QUALITY-ASSURANCE DATA FOR ROUTINE WATER ANALYSIS IN THE LABORATORIES OF THE U.S. GEOLOGICAL SURVEY FOR WATER YEAR 1986

By Keith J. Lucey and Dale B. Peart

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ABSTRACT

The U.S. Geological Survey maintained a quality-assurance program based on the analysis of reference samples for its two water-analysis laboratories located in Atlanta, Georgia, and Denver, Colorado. After the Atlanta laboratory was closed on December 31, 1985, the program was continued at the National Water Quality Laboratory in Denver. Reference samples containing selected inorganic constituents are prepared at the Survey's Water Quality Services Unit in Ocala, Florida, disguised as routine samples, and sent daily or weekly, as appropriate, to each laboratory through other Survey offices. The results are stored permanently in the National Water Data Storage and Retrieval System (WATSTORE), the Survey's data base for all water data. These data are analyzed statistically for precision, bias, and comparability. The results of these statistical analyses are discussed for data collected during water year 1986. Nutrient samples and precipitation samples also were submitted as samples of unknown concentrations. The results were analyzed statistically for precision, bias, and comparability, and these data also are discussed. Because of the closure of the Atlanta laboratory, comparable statistics between the two laboratories are only available for the first quarter of the water year.

An overall evaluation of the major and trace constituent data for water year 1986 indicated a lack of precision in the Atlanta laboratory for the determination of five constituents and in the Denver laboratory for nine constituents. There were fewer constituents having positive or negative bias during water year 1986 than during water year 1985 at the Atlanta laboratory. A biased condition existed in the determination of six common constituents at both laboratories.

Acceptable precision was indicated for determinations of all nutrient constituents at both laboratories. A biased condition existed in the determination of three nutrient constituents at the Denver laboratory.

For precipitation samples at the Denver laboratory, there was acceptable precision in the determination of all constituents; however, a biased condition was indicated for four constituents. Because the Atlanta Laboratory was operational for only a small part of the year, there were an insufficient number of samples analyzed for statistical tests to determine precision and bias.

INTRODUCTION

The water-quality laboratories of the U.S. Geological Survey, located in Atlanta, Ga., and Denver, Colo., routinely analyze water, suspended sediment, streambed materials and lakebed materials for inorganic constituents, many organic substances, including common pesticides, priority pollutants as defined by the U.S. Environmental Protection Agency (Keith and Telliard, 1979), and some physical properties. Results of the quality-assurance program used to monitor the quality of work at these two laboratories are discussed in this report. Previous reports (Peart and Thomas, 1983a, 1983b, 1984; Peart and Sutphin, 1987; Lucey and Peart, 1988) document results from February 1981 through September 1985.

The laboratory in Atlanta was closed at the end of calendar year 1986 to consolidate operations into the National Water Quality Laboratory in Denver, Colo. As a result, comparable statistics between the laboratories are available only for the first quarter of the water year. However, the quality-assurance program was continued throughout the water year to monitor the quality of work at the laboratory in Denver.

Factors that need to be considered for data interpretation for this period in conjunction with the results presented in this report include the following:

1. Nonanalytical errors were not corrected so the data is preserved as the laboratory produced it. Therefore, if the data reviewer, in the Survey's office that collected the sample, is familiar with the collection site or the historical water-quality data from that site, many errors of this type could be easily corrected. For example, two samples from different sites are submitted to the laboratory on the same day and are misidentified, in a way that the analytical data reported for one, would actually belong to the other. A data reviewer who was familiar with the site or its historical data usually could detect the problem and correct it.

2. No quality-assurance samples had any constituents re-determined except those requested by the laboratories internal quality-assurance groups. Survey data reviewers in the offices that collected the samples are expected to scrutinize incoming new data for discrepancies and make requests for re-analysis. These requests may result in the detection of analytical and nonanalytical errors, and data quality would improve, when compared to data quality presented in this report.

3. Figures included in this report may be used to determine analytical conditions at any given time for water year 1986. Where figures show that an analytical process has been in statistical control for most of the year, but the process also has been out of statistical control for a certain period, that period may be long enough that the statistical tests applied indicate lack of precision or significant bias for the year. The data from that period when the analytical process was in control can be considered to have acceptable precision and bias.

During water year 1986, the following sample categories, containing the indicated constituents were included in this quality-assurance program:

Inorganic constituents—alkalinity, aluminum, antimony, arsenic, barium, beryllium, boron, cadmium, calcium, chloride, chromium, cobalt, copper, dissolved solids (residue on evaporation at 180°C), fluoride, iron, lead, lithium, magnesium, manganese, molybdenum, nickel, potassium, selenium, silica, silver, sodium, strontium, sulfate, and zinc.

Nutrients—ammonia, as nitrogen; ammonia plus organic nitrogen as nitrogen; nitrite as nitrogen; nitrite plus nitrate as nitrogen; orthophosphate as phosphorus; and phosphorus.

Precipitation—minute concentrations of: ammonia, as nitrogen; calcium; chloride; fluoride; magnesium; nitrate, as nitrogen; phosphorus; potassium; sodium; and sulfate.

PROGRAM DESCRIPTION

Standard reference water samples (SRWS's) (Skougstad and Fishman, 1975; Schroder and others, 1980; Janzer, 1985) are used as the principal component of the reference samples used in this program. The SRWS's are diluted with deionized water, mixed in varying proportions with other SRWS's, or used undiluted. A large range of concentrations of chemical constituents is achieved, thereby increasing the number of unique samples available for quality-assurance purposes. This increase, in turn, decreases the probability that quality-assurance samples will be recognized in the laboratory because of frequency of analyses or unique sample behavior.

In addition to the SRWS's, synthetic samples made from reagent-grade chemicals are used in preparing reference samples. All samples are prepared at the Water Quality Service Unit in the Survey's Ocala, Florida office, and are made to appear as much like environmental samples as possible. When the samples are prepared and proper forms are completed to ensure that appropriate constituents have been requested for the sample, the samples and the forms are shipped to selected Survey offices across the country. These Survey offices then ship the quality-assurance samples to the laboratories on a daily or weekly basis, as appropriate, with their regular samples.

The number of quality-assurance determinations requested for inorganic constituents and nutrients are in direct proportion to the total number of requests for those determinations from all sources in the laboratory. The program goal is to have at least one quality-assurance sample analyzed daily for those constituents that are analyzed daily, and, similarly, to have an appropriate number of quality-assurance samples analyzed for those constituents determined less frequently. Precipitation (natural and simulated) samples were submitted once each week.

All constituents in the reference materials are in the dissolved phase because the reference materials themselves have been filtered in the preparation process. Therefore, those constituents in this report that are designated as "total recoverable" are from reference samples that have undergone a digestion process (Fishman and Friedman, 1985, p 87–88) during analysis, rather than from unfiltered or whole-water samples. Differences that appear in this report between the dissolved analyses and the total recoverable analyses will be due largely or entirely to the digestion process rather than from any difference in the sampling techniques or sample source.

Quality-assurance samples are processed by each laboratory as routine samples, including the normal laboratory quality-control and quality-assurance procedures. The data then are stored in the Survey's National Water Data Storage and Retrieval System (WATSTORE). After being processed by the laboratories, data from these quality-assurance samples will indicate the quality of the analytical data that the laboratories produce for environmental samples. Laboratory errors, other than those related to analytical chemistry, also will be included in these data. These errors include any made in logging the sample into the laboratory, transcription errors by the analyst, and keypunching errors. No effort was made to correct nonanalytical errors of this type, even when it was obvious which corrective measures were appropriate, and the laboratories' data were preserved as they produced them. Therefore, if a data user is capable of detecting errors of this type, he or she can improve the quality of the data, when compared to those data presented in this report.

STATISTICAL EVALUATION

The SRWS's initially are analyzed by many laboratories throughout the United States, using several different analytical methods. The results are compiled by calculating the means, standard deviations, and 95-percent confidence limits, and then applying a rejection routine (American Society for Testing and Materials, 1980). Resultant means are the most probably correct values or the most probable values (MPV's). These MPV's are used in this quality-assurance program for comparison with laboratory data. For reference samples composed of a mixture of two SRWS's, or SRWS's and deionized water, the MPV's for each constituent are weight-averaged according to their respective percentage contributions to determine a new set of MPV's for the mixture.

Standard deviations were determined by using linear least squares equations developed by regressing the means of each constituent obtained from all the SRWS's used during the last seven years against the corresponding standard deviations for those constituents. This method enabled an estimation of a most probable standard deviation (MPSD) for each constituent on a sample-by-sample basis to ascertain whether the determination in question was statistically in or out of control. An individual reported value was considered in statistical control if it was within two standard deviations of the MPV.

In certain situations, the resulting equation produced a MPSD too small for the standard deviation criterion to be met. This was true for aluminum, arsenic, barium, cadmium, chromium, copper, fluoride, lead, lithium, molybdenum, nickel, selenium, and silver; and also when iron, manganese and zinc are determined by atomic absorption spectrometry or total recoverable digestion. An administrative decision was made to establish a minimum standard deviation for each of these constituents equal to three-quarters of the value of the reporting level to allow at least one reportable value on each side of the MPV to be accepted. For example, the minimum standard deviation for copper reported to the nearest 10 μg/L (micrograms per liter) is set to 7.5 μg/L; the minimum standard deviation for silver, reported to the nearest 1 μg/L, is 0.75 μg/L. The equations for determining the most probable standard deviation (MPSD) for each constituent and the established minimum MPSD, if any, are listed in table 1.

The number of standard deviations each constituent differs from the MPV was calculated by dividing the difference of the reported value and the MPV by the MPSD. This number was used in determining precision and bias. The results for each laboratory and each constituent are shown on control charts in figures 1 through 128 in the "Supplemental Data" section at the back of this report. Three symbols are used in figures 1 through 106 to indicate results from the lower (+), middle (x), and upper (o) one-thirds of the potential analytical range tested in this program for inorganic constituents. This range does not necessarily correspond with the analytical capabilities of the laboratory instrumentation or methods, but rather corresponds with the analytical range tested using the available SRWS's or other reference samples. The three parts of this range are based on the MPV's of the quality-assurance samples and not on the reporting policy; for example, available resources limit the maximum MPV for sodium to be 119.0 mg/L (figs. 93 and 94) and still allow a correctly reported value of 120 mg/L, based on the policy to report sodium to the nearest 10 mg/L at this concentration. Not all figures will show all three parts of the analytical range, because some flexibility is given to the Ocala, Fla., office in sample selection and because of limited concentration ranges in the available SRWS's. Results for nutrient constituents are indicated in figures 107 through 118 and for precipitation sample results are indicated in figures 119 through 128. Due to the low-level concentrations of these constituents, symbols on these plots represent the entire potential analytical range tested. Points outside the range of the plots are forced to appear at the limit (±6 standard deviations), with the actual number of standard deviations indicated adjacent to the point (see fig. 2, for example).

Table 1.—*Linear least-squared equations for determining the most probable standard deviation*

[MPSD, most probable standard deviation; mg/L, milligrams per liter; MPV, most probable value; ‡, not applicable; µg/L, micrograms per liter; ICP, inductively coupled plasma emission spectrometry; AA, atomic absorption spectrometry; TOT, total recoverable; N, nitrogen; P, phosphorus.]

Constituent (dissolved except as indicated)	Units	Equation	Minimum MPSD
Inorganic Constituents:			
Alkalinity	mg/L	(0.021 x MPV) + 1.14	‡
Aluminum	µg/L	(0.17 x MPV) + 30.4	7.5
Antimony	µg/L	(0.0 x MPV) + .88	0.88
Arsenic	µg/L	(0.11 x MPV) + 1.27	0.75
Barium (ICP)	µg/L	(0.16 x MPV) + 7.49	0.75
Barium (AA)	µg/L	(0.17 x MPV) + 26.0	75
Barium (TOT)	µg/L	(0.17 x MPV) + 26.0	75
Beryllium	µg/L	(0.043 x MPV) + 1.45	‡
Boron	mg/L	(0.042 x MPV) + 33.2	‡
Cadmium (ICP)	µg/L	(0.106 x MPV) + 0.72	0.75
Cadmium (AA)	µg/L	(0.106 x MPV) + 0.72	0.75
Cadmium (TOT)	µg/L	(0.106 x MPV) + 0.72	0.75
Calcium (ICP)	mg/L	(0.040 x MPV) + 0.54	‡
Calcium (AA)	mg/L	(0.040 x MPV) + 0.54	‡
Chloride	mg/L	(0.026 x MPV) + 0.62	‡
Chromium	µg/L	(0.16 x MPV) + 1.49	7.5
Chromium (TOT)	µg/L	(0.16 x MPV) + 1.49	7.5
Cobalt (ICP)	µg/L	(0.075 x MPV) + 2.09	‡
Cobalt (AA)	µg/L	(0.075 x MPV) + 2.09	‡
Cobalt (TOT)	µg/L	(0.075 x MPV) + 2.09	‡
Copper (ICP)	µg/L	(0.046 x MPV) + 3.25	7.5
Copper (AA)	µg/L	(0.046 x MPV) + 3.25	0.75
Copper (TOT)	µg/L	(0.046 x MPV) + 3.25	0.75
Dissolved solids	mg/L	(0.022 x MPV) + 7.2	‡
Fluoride	mg/L	(0.071 x MPV) + 0.01	0.05
Iron (ICP)	µg/L	(0.042 x MPV) + 8.60	‡
Iron (AA)	µg/L	(0.042 x MPV) + 8.60	7.5
Iron (TOT)	µg/L	(0.042 x MPV) + 8.60	7.5
Lead (ICP)	µg/L	(0.531 x MPV) - 0.16	7.5
Lead (AA)	µg/L	(0.531 x MPV) - 0.16	3.75
Lead (TOT)	µg/L	(0.531 x MPV) - 0.16	3.75
Lithium	µg/L	(0.11 x MPV) + 1.73	7.5
Magnesium (ICP)	mg/L	(0.035 x MPV) + 0.26	‡
Magnesium (AA)	mg/L	(0.035 x MPV) + 0.26	‡
Manganese (ICP)	µg/L	(0.044 x MPV) + 2.52	‡
Manganese (AA)	µg/L	(0.044 x MPV) + 2.52	7.5

Table 1.—*Linear least-squared equations for determining the most probable standard deviation*— **Continued**

Constituent (dissolved except as indicated)	Units	Equation	Minimum MPSD
Manganese (TOT)	µg/L	(0.044 x MPV) + 2.52	7.5
Molybdenum (ICP)	µg/L	(0.081 x MPV) + 4.21	7.5
Molybdenum (AA)	µg/L	(0.081 x MPV) + 4.21	0.75
Nickel	µg/L	(0.109 x MPV) + 4.52	7.5
Nickel (TOT)	µg/L	(0.109 x MPV) + 4.52	7.5
Potassium	mg/L	(0.075 x MPV) + 0.07	‡
Selenium	µg/L	(0.347 x MPV) - 0.30	0.75
Silica	mg/L	(0.038 x MPV) + 0.53	‡
Silver	µg/L	(0.260 x MPV) + 1.06	0.75
Silver (TOT)	µg/L	(0.260 x MPV) + 1.06	0.75
Sodium (ICP)	mg/L	(0.032 x MPV) + 0.23	‡
Sodium (AA)	mg/L	(0.032 x MPV) + 0.23	‡
Strontium	µg/L	(0.039 x MPV) + 9.30	‡
Sulfate	mg/L	(0.045 x MPV) + 1.20	‡
Zinc (ICP)	µg/L	(0.039 x MPV) + 4.39	‡
Zinc (AA)	µg/L	(0.039 x MPV) + 4.39	7.5
Zinc (TOT)	µg/L	(0.039 x MPV) + 4.39	7.5
Nutrient Constituents:			
Ammonia nitrogen, as N	mg/L	(0.10 x MPV) + 0.035	‡
Ammonia plus organic nitrogen, as N	mg/L	(0.601 x MPV) - 0.06	‡
Nitrate plus nitrite nitrogen, as N	mg/L	(0.038 x MPV) + 0.034	‡
Nitrate nitrogen, as N	mg/L	(0.07 x MPV) + 0.003	‡
Phosphorus, as P	mg/L	(0.076 x MPV) + 0.007	‡
Orthophosphate, as P	mg/L	(0.057 x MPV) + 0.009	‡
Constituents in precipitation samples:			
Calcium	mg/L	(0.065 x MPV) + 0.05	‡
Chloride	mg/L	(0.073 x MPV) + 0.20	‡
Fluoride	mg/L	(-.08 x MPV) + 0.031	‡
Magnesium	mg/L	(0.038 x MPV) + 0.014	‡
Ammonia nitrogen, as N	mg/L	(0.32 x MPV) + 0.008	‡
Nitrate nitrogen, as N	mg/L	(0.23 x MPV) + 0.018	‡
Phosphorus, as P	mg/L	(0.064 x MPV) + 0.008	‡
Potassium	mg/L	(0.10 x MPV) + 0.02	‡
Sodium	mg/L	(0.044 x MPV) + 0.04	‡
Sulfate	mg/L	(0.037 x MPV) + 0.035	‡

Precision and bias are determined by applying binomial-probability-distribution equations to the data using procedures described by Friedman, Bradford, and Peart, (1983); and by Peart and Thomas, (1983a). When precision is determined using these procedures, it contains an element of bias because MPV's, rather than analyzed means, are used as the basis for determining the number of standard deviations each constituent deviates from that value. Therefore, in this analysis, precision, or lack of it, is based on whether or not the analytical process was statistically in or out of control. Figures 1–128 are control charts.

Calculation of means and relative standard deviations (Miller and Freund, 1977) were made for each major constituent with sufficient data. Because standard deviations may vary proportionally as constituent concentration in chemical analyses varies, these calculations were done separately for individual sample mixtures; therefore, they do not result in overall evaluations of the analytical processes. Relative standard deviations for inorganic, nutrient, and precipitation constituents were calculated and plotted as a percentage of their mean concentrations (figs. 129 through 254 in the "Supplemental data" section at the back of this report.) These plots allow a data reviewer to estimate the error at any concentration shown for all constituents. For example, the precision of the alkalinity values from the Atlanta laboratory are estimated to be ±1 percent from figure 129. The precision of the alkalinity values from the Denver laboratory are estimated to be ±3 percent from figure 130. To allow the precision charts to be used to estimate an expected error from the analytical results, outliers were deleted from the data set. An outlier was defined as being greater than 6 or less than –6 standard deviations from the MPV. The total number of analyses for each constituent processed during the water year at each laboratory, the number of analyses with standard deviations greater than 2 or less than –2 from the MPV, and the number of analyses with standard deviations greater than 6 or less than –6 from the MPV are listed in Table 2. If the relative standard deviation for a given mix has a value of zero, the data point will plot on the horizontal axis, as in figures 157, 201, and 202. There are no data points in figures 153, 193, or 221 but the plots were kept in the report to maintain the established format, enabling the same data from the two laboratories to be shown on the same page.

Because of an insufficient supply of SRWS's for nutrients, most of the reference materials were made from reagent-grade chemicals in the Ocala, Fla., office. Preparation methods used for these samples were virtually the same as those used for preparing samples for the SRWS program. Precipitation samples were either SRWS's initially prepared from natural matrix materials (Janzer, 1985) or were regular SRWS's that were diluted so that the constituent concentrations were similar to those in natural precipitation.

COMPARISON OF STATISTICAL DATA FOR INORGANIC-CONSTITUENT SAMPLES BETWEEN LABORATORIES

Several data points seemed to be in error because of an incorrectly applied dilution factor. Dilutions of the sample are made routinely in the laboratory to bring the sample concentration into analytical range. If the dilution factor is not applied or is applied incorrectly, the reported value will be in error by the magnitude of the dilution factor. For example, if several analyses of a solution result in reported values of 250 mg/L each and one analysis results in a reported value of 25 mg/L, a 10X dilution may have been used and not applied to the final results. These kinds of errors are difficult to confirm. Their detection and correction in the field offices will increase the reliability of the data above that stated in this report.

Precision

The results of statistical testing for lack of precision for each inorganic constituent are presented in table 3. For each constituent, this table indicates significant lack of precision at the 95 percent confidence level (indicated by "LOP") as well as all acceptable results (indicated by " + ").

Evaluating the data for the year, chromium, total recoverable; iron, (AA); iron, total recoverable; sodium (ICP); and sodium (AA) indicated LOP in the Atlanta laboratory. Calcium (AA); chloride; iron (ICP); iron, total recoverable; selenium; sodium (AA); zinc (ICP); zinc (AA); and zinc, total recoverable indicated LOP in the Denver laboratory. Constituents indicating LOP in both laboratories during 1986 are iron, total recoverable and sodium (AA) .

Iron, total recoverable, failed the precision criteria in the Atlanta laboratory during water year 1986 as it did during water years 1982, 1983, 1984, and 1985. In the Denver laboratory, sodium (AA); iron, total recoverable; selenium; and zinc (ICP) all failed the precision criteria during water years 1985 and again in 1986 (Peart and Thomas, 1983b, 1984; Peart and Sutphin, 1987; Lucey and Peart, 1988). Only iron, total recoverable has failed the precision test at both laboratories during each of the last 2 years.

Table 2.—*Total number of analyses from quality-assurance samples during water year 1986 at the Atlanta and Denver laboratories*

[>2SD, number of analyses greater than 2 or less than -2 standard deviations from the most probable value; >6SD, number of analyses greater than 6 or less than -6 standard deviations from the most probable value; ICP, inductively coupled plasma emission spectrometry; AA, atomic absorption spectrometry; TOT, total recoverable; N, nitrogen; P, phosphorus]

Constituent (dissolved except as indicated)	Number of analyses at the Atlanta laboratory			Number of analyses at the Denver laboratory		
	Total	>2SD	>6SD	Total	>2SD	>6SD
Inorganic Constituents:						
Alkalinity	27	0	0	405	4	2
Aluminum	13	0	0	137	3	0
Antimony	1	0	0	22	0	0
Arsenic	26	0	0	279	1	0
Barium (ICP)	12	0	0	121	1	0
Barium (AA)	8	0	0	71	1	0
Barium (TOT)	7	1	0	70	0	0
Beryllium	13	0	0	121	6	2
Boron	8	0	0	137	0	0
Cadmium (AA)	20	1	0	187	2	1
Cadmium (ICP)	15	0	0	160	5	0
Cadmium (TOT)	7	1	0	70	3	0
Calcium (ICP)	24	0	0	317	4	0
Calcium (AA)	3	0	0	50	8	1
Chloride	27	2	0	404	78	4
Chromium	20	3	0	209	11	1
Chromium (TOT)	7	5	0	70	3	0
Cobalt (ICP)	15	0	0	174	2	1
Cobalt (AA)	8	0	0	71	0	0
Cobalt (TOT)	7	1	0	70	1	0
Copper (ICP)	15	0	0	159	11	1
Copper (AA)	20	2	2	182	6	3
Copper (TOT)	70	0	0	71	3	0
Dissolved solids	24	0	0	382	22	3
Fluoride	27	1	0	403	26	2
Iron (ICP)	12	1	1	121	22	11
Iron (AA)	20	11	1	187	12	2
Iron (TOT)	7	4	1	71	13	6
Lead (ICP)	15	2	0	168	2	0
Lead (AA)	20	1	0	188	0	0
Lead (TOT)	7	0	0	70	2	0
Lithium	13	0	0	121	1	1
Magnesium (ICP)	24	1	0	317	2	0
Magnesium (AA)	3	0	0	50	5	0
Manganese (ICP)	12	3	1	121	4	0

Table 2.—*Total number of analyses from quality-assurance samples during water year 1986 at the Atlanta and Denver laboratories*—**Continued**

Constituent (dissolved except as indicated)	Number of analyses at the Atlanta laboratory			Number of analyses at the Denver laboratory		
	Total	>2SD	>6SD	Total	>2SD	>6SD
Manganese (AA)	20	1	1	187	9	0
Manganese (TOT)	7	1	1	71	0	0
Molybdenum (ICP)	12	0	0	135	0	0
Molybdenum (AA)	13	1	1	116	0	0
Nickel	20	0	0	209	1	0
Nickel (TOT)	7	0	0	70	0	0
Potassium	27	0	0	363	8	3
Selenium	13	0	0	164	27	0
Silica	27	0	0	403	3	1
Silver	8	0	0	94	0	0
Silver (TOT)	7	0	0	70	0	0
Sodium (ICP)	24	5	0	319	15	1
Sodium (AA)	3	2	0	51	12	3
Strontium	13	1	1	121	2	1
Sulfate	27	1	1	404	13	0
Zinc (ICP)	12	1	0	122	30	16
Zinc (AA)	20	4	0	18	31	2
Zinc (TOT)	7	1	0	71	14	2
Nutrient Constituents:						
Ammonia nitrogen, as N	9	0	0	267	5	1
Ammonia + organic nitrogen, as N	13	0	0	330	0	0
Nitrate + nitrite nitrogen, as N	19	0	0	421	5	1
Nitrite nitrogen, as N	2	0	0	92	9	0
Orthophosphate, as P	5	0	0	129	6	2
Phosphorus, as P	16	1	1	328	21	13
Constituents in precipitation samples:						
Calcium	0	0	0	38	3	3
Chloride	0	0	0	40	0	0
Fluoride	0	0	0	40	1	0
Magnesium	0	0	0	38	5	3
Ammonia nitrogen, as N	0	0	0	17	0	0
Nitrate nitrogen, as N	0	0	0	39	0	0
Phosphorus, as P	0	0	0	5	0	0
Potassium	0	0	0	40	0	0
Sodium	0	0	0	38	2	0
Sulfate	0	0	0	40	2	1

Table 3.—*Results of statistical testing for lack of precision in inorganic constituent data from the Atlanta and Denver laboratories*

[+, acceptable results; *, too few analyses to determine; ICP, inductively coupled plasma emission spectrometry; AA, atomic absorption spectrometry; LOP, significant lack of precision]

Constituent (dissolved, except as indicated)	Results from the Atlanta laboratory Oct. 1985–Sept. 1986	Results from the Denver laboratory Oct. 1985–Sept. 1986
Alkalinity	+	+
Aluminum	+	+
Antimony	*	+
Arsenic	+	+
Barium (ICP)	+	+
Barium (AA)	+	+
Barium, total recoverable	+	+
Beryllium	+	+
Boron	+	+
Cadmium (ICP)	+	+
Cadmium (AA)	+	+
Cadmium, total recoverable	+	+
Calcium (ICP)	+	+
Calcium (AA)	+	LOP
Chloride	+	LOP
Chromium	+	+
Chromium, total recoverable	LOP	+
Cobalt (ICP)	+	+
Cobalt (AA)	+	+
Cobalt, total recoverable	+	+
Copper (ICP)	+	+
Copper (AA)	+	+
Copper, total recoverable	+	+
Dissolved solids	+	+
Fluoride	+	+
Iron (ICP)	+	LOP
Iron (AA)	LOP	+
Iron, total recoverable	LOP	LOP
Lead (ICP)	+	+
Lead (AA)	+	+
Lead, total recoverable	+	+
Lithium	+	+
Magnesium (ICP)	+	+
Magnesium (AA)	+	+
Manganese (ICP)	+	+
Manganese (AA)	+	+
Manganese, total recoverable	+	+
Molybdenum (ICP)	+	+
Molybdenum (AA)	+	+
Nickel	+	+
Nickel, total recoverable	+	+

Table 3.—*Results of statistical testing for lack of precision in inorganic constituent data from the Atlanta and Denver laboratories*—**Continued**

Constituent (dissolved, except as indicated)	Results from the Atlanta laboratory Oct. 1985–Sept. 1986	Results from the Denver laboratory Oct. 1985–Sept. 1986
Potassium	+	+
Selenium	+	LOP
Silica	+	+
Silver	+	+
Silver, total recoverable	+	+
Sodium (ICP)	LOP	+
Sodium (AA)	LOP	LOP
Strontium	+	+
Sulfate	+	+
Zinc (ICP)	+	LOP
Zinc (AA)	+	LOP
Zinc, total recoverable	+	LOP

In the Atlanta laboratory during water year 1986, cadmium (AA); cobalt, total recoverable; dissolved solids; fluoride; lead, total recoverable; and selenium had acceptable results after failing the precision tests during water year 1985. In the Denver laboratory, barium, total recoverable; fluoride; and molybdenum (AA) had acceptable results during water year 1986 after having a lack of precision during water year 1985 (Lucey and Peart, 1988).

Bias

Results of the statistical tests for bias are presented in table 4. When the method described in the Statistical Evaluation section was used, bias could not be determined when results from less than eight samples were available. This situation was applicable for antimony, calcium (AA), magnesium (AA), and sodium (AA) at the Atlanta laboratory during its shortened year of operations.

There were fewer constituents with biased data for water year 1986 than for water year 1985 at the Atlanta laboratory (Lucey and Peart, 1988). Negatively biased constituents, consistent with results for water year 1985, were: barium (ICP), iron (AA), manganese (ICP), and molybdenum (AA). Results for aluminum and silver had a negative bias in the data during water year 1986, but were not biased during the previous water year.

For the Atlanta laboratory, the only positively biased constituent during water year 1986 that was also positively biased for water year 1985 was barium, total recoverable. Additional constituents that had positive bias in the data for water year 1986 but not for water year 1985 were molybdenum (ICP) and selenium (Lucey and Peart, 1988).

There were more constituents with biased results during water year 1986 than during water year 1985 at the Denver laboratory. Negatively biased constituents, consistent with results for water year 1985, were: barium (ICP), boron, cobalt (ICP), molybdenum (AA), and potassium. Additional constituents that had a negative bias during water year 1986 but not during water year 1985 were: antimony; beryllium; cadmium (ICP); cadmium (AA); cadmium, total recoverable; cobalt (AA); cobalt, total recoverable; copper (ICP); copper, total recoverable; dissolved solids; lead (ICP); manganese (ICP); and strontium. Positively biased constituents consistent with results for water year 1985 were: barium (AA); barium, total recoverable; chromium; iron (AA); magnesium (ICP); selenium; silica; sodium (ICP); sulfate; and zinc (ICP). Additional positively biased constituents that did not have a positive bias during water year 1985 were: arsenic; fluoride; iron (ICP); iron, total recoverable; and molybdenum (ICP).

Table 4.—*Results of statistical testing for bias in inorganic constituent data from the Atlanta and Denver laboratories*

[+, acceptable results; N, negative bias; *, too few analyses to determine; P, positive bias; ICP, inductively coupled plasma emission spectrometry; AA, atomic absorption spectrometry]

Constituent (dissolved, except as indicated)	Results from the Atlanta laboratory Oct. 1985–Sept. 1986	Results from the Denver laboratory Oct. 1985–Sept. 1986
Alkalinity	+	+
Aluminum	N	+
Antimony	*	N
Arsenic	+	P
Barium (ICP)	N	N
Barium (AA)	+	P[1]
Barium, total recoverable	P[1]	P[1]
Beryllium	+	N
Boron	+	N
Cadmium (ICP)	+	N
Cadmium (AA)	+	N
Cadmium, total recoverable	+	N
Calcium (ICP)	+	+
Calcium (AA)	*	+
Chloride	+	+
Chromium	+	P[1]
Chromium, total recoverable	+	+
Cobalt (ICP)	+	N
Cobalt (AA)	+	N
Cobalt, total recoverable	+	N
Copper (ICP)	+	N
Copper (AA)	+	+
Copper, total recoverable	+	N
Dissolved solids	+	N
Fluoride	+	P
Iron (ICP)	+	P
Iron (AA)	N	P
Iron, total recoverable	+	P
Lead (ICP)	+	N
Lead (AA)	+	+
Lead, total recoverable	+	+
Lithium	+	+
Magnesium (ICP)	+	P
Magnesium (AA)	*	+
Manganese (ICP)	N	N
Manganese (AA)	+	+
Manganese, total recoverable	+	+
Molybdenum (ICP)	P	P
Molybdenum (AA)	N	N
Nickel	+	+
Nickel, total recoverable	+	+
Potassium	+	N

Table 4.—**Results of statistical testing for bias in inorganic constituent data from the Atlanta and Denver laboratories**—*Continued*

Constituent (dissolved, except as indicated)	Results from the Atlanta laboratory Oct. 1985–Sept. 1986	Results from the Denver laboratory Oct. 1985–Sept. 1986
Selenium	P	P
Silica	+	P
Silver	N	+
Silver, total recoverable	+	+
Sodium (ICP)	+	P
Sodium (AA)	*	+
Strontium	+	N
Sulfate	+	P
Zinc (ICP)	+	P
Zinc (AA)	+	+
Zinc, total recoverable	+	+

[1]Bias occurs because some most probable values are less than the minimum reporting limit.

There were no predominant patterns for bias between dissolved versus total recoverable analyses or between ICP and AA determinations for either laboratory. For barium (AA); barium, total recoverable; and chromium; a biased condition occurred because the minimum reporting levels (barium,100 µg/L and chromium,10 µg/L) were greater than the MPV's.

Because the Denver laboratory has more constituents with biased data than does the Atlanta laboratory, the problems related to bias seem unlikely to be inherent in the methods used for determination of these constituents, except where that bias is persistent in both laboratories. During water year 1986, the following four constituents had data with a positive bias in both laboratories: barium, total recoverable; molybdenum (ICP); and selenium. Three constituents had data with a negative bias in both laboratories: barium (ICP), manganese (ICP), and molybdenum (AA). When quality assurance data from water year 1985 are considered, (Lucey and Peart, 1988) a persistent bias is indicated for the determination of barium (ICP); barium, total recoverable; and molybdenum (AA) for the past 2 years in both laboratories.

The control chart for dissolved alkalinity for the Denver laboratory (fig. 2) shows a definite negative bias in the first 2 months of the water year. These results at -1.0 standard deviation from the MPV are a continuation of a trend that began in the first quarter of water year 1985 (Lucey and Peart, 1988). The change from ±0.25 standard deviation from the MPV to -1.0 standard deviation during water-year 1985 may have been due to a deterioration in one or more instrumental components. However, the results returned to an unbiased condition after the first 2 months of the 1986 water year. The determination of dissolved alkalinity at the Atlanta laboratory remained ±0.5 standard deviation from theoretical throughout water year 1985 and the first month of water year 1986 (fig. 1).

The control chart for dissolved solids at the Denver laboratory (fig. 48) indicates a trend to a positive bias in the last month of water year 1986. Several analyses have values greater than 2 standard deviations from the MPV.

There were several analyses with values greater than 2 standard deviations from the MPV for iron (ICP) during June at the Denver laboratory (fig. 52). This could be due to either contamination of the samples during preparation of the SRWS mix or prior to analysis at the Denver laboratory.This uncertainty could be resolved if comparable data had been available from two laboratories instead of only one.

The pattern of clustered points on the control charts for chromium (fig. 32), lead (AA) (fig. 60), molybdenum (AA) (fig. 78), silver (fig. 90), and zinc (AA) (fig. 104) are due to variations in concentrations of the constituent in the SRWS mixes. As discussed previously, a minimum standard deviation was established in certain situations (such as low concentrations) equal to three-fourths of the value of the reporting level. In the case of zinc, concentrations greater than 5000 mg/L in some of the SRWS mixes also contribute to the clustering.

Several factors may have affected the results for other constituents that indicated occasional bias; the factors may include deterioration of standard calibrating solutions or reagents, improper or inaccurate reagent or standard-solution preparation, undetected problems with analytical instrumentation, undefined matrix effects caused by mixing together two markedly different SRWS's, reporting levels being higher than the MPV's or undetected contamination. When bias is indicated statistically but precision is good, the bias may have minimal effect on data interpretation and minimal practical significance.

COMPARISON OF STATISTICAL DATA FOR NUTRIENT-CONSTITUENT SAMPLES BETWEEN LABORATORIES

Precision

The results of statistical testing for lack of precision for each nutrient constituent are presented in table 5. Results for all nutrient constituents at both laboratories passed the precision test during water year 1986.

Table 5.—*Results of statistical testing for lack of precision in nutrient constituent data from the Atlanta and Denver laboratories*

[N, nitrogen; +, acceptable results; *, too few analyses to determine; P, phosphorus]

Constituent (dissolved, except as indicated)	Results from the Atlanta laboratory Oct. 1985–Sept. 1986	Results from the Denver laboratory Oct. 1985–Sept. 1986
Ammonia nitrogen, as N	+	+
Ammonia + organic nitrogen, as N	+	+
Nitrite + nitrate nitrogen, as N	*	+
Nitrite nitrogen, as N	+	+
Orthophosphate, as P	+	+
Phosphorus, as P	+	+

Bias

Results of the statistical tests for bias are presented in table 6. There were an insufficient number of samples for this analysis for nitrite as nitrogen and orthophosphate as phosphorus at the Atlanta laboratory. The results for the other four nutrient constituents at the Atlanta laboratory did not indicate bias.

At the Denver laboratory, results for ammonia as nitrogen indicate a negative bias, while results for nitrite plus nitrate as nitrogen, and nitrite as nitrogen indicate a positive bias.

STATISTICAL DATA FOR PRECIPITATION SAMPLES

The results for statistical testing for lack of precision and bias for each constituent in the precipitation and simulated-precipitation samples are presented in tables 7 and 8, respectively. Only data for the Denver laboratory were analyzed, because there were an insufficient number of samples from the Atlanta laboratory for the statistical tests.

Table 6.—*Results of statistical testing for bias in nutrient constituent data from the Atlanta and Denver laboratories*

[N, nitrogen; +, acceptable results; n, negative bias; p, positive bias; *, too few analyses to determine; P, phosphorus]

Constituent (dissolved, except as indicated)	Results from the Atlanta laboratory Oct. 1985–Sept. 1986	Results from the Denver laboratory Oct. 1985–Sept. 1986
Ammonia nitrogen, as N	+	n
Ammonia + organic nitrogen, as N	+	+
Nitrite + nitrate nitrogen, as N	+	p
Nitrite nitrogen, as N	*	p
Orthophosphate, as P	*	+
Phosphorus, as P	+	+

Results for all of the constituents in the precipitation samples indicated acceptable precision for water year 1986. Results for three constituents (ammonia as nitrogen, magnesium, and potassium) indicate a negative bias, whereas results for fluoride indicate a positive bias.

Table 7.—*Results of statistical testing for lack of precision in precipitation constituent data from the Atlanta and Denver laboratories*

[*, too few analyses to determine; +, acceptable results; N, nitrogen; P, phosphorus]

Constituent (dissolved, except as indicated)	Results from the Atlanta laboratory Oct. 1985–Sept. 1986	Results from the Denver laboratory Oct. 1985–Sept. 1986
Ammonia nitrogen, as N	*	+
Calcium	*	+
Chloride	*	+
Fluoride	*	+
Magnesium	*	+
Nitrate nitrogen, as N	*	+
Phosphorus, as P	*	+
Potassium	*	+
Sodium	*	+
Sulfate	*	+

SUMMARY AND CONCLUSIONS

Reference water samples that had known MPV's were disguised as regular samples and submitted with environmental water samples by selected offices of the Survey to the two water-analysis laboratories operated by the Survey in Atlanta, Ga., and in Denver, Colo. The resulting data were stored in WATSTORE. Data for inorganic constituents, nutrient constituents, and constituents in precipitation samples then were analyzed statistically for precision and bias by using a binomial-probability-distribution equation.

Table 8.—*Results of statistical testing for bias in precipitation constituent data from the Atlanta and Denver laboratories*

[N, nitrogen; *, too few analyses to determine; +, acceptable results; n, negative bias; p, positive bias; P, phosphorus]

Constituent (dissolved, except as indicated)	Results from the Atlanta laboratory Oct. 1985–Sept. 1986	Results from the Denver laboratory Oct. 1985–Sept. 1986
Ammonia nitrogen, as N	*	n
Calcium	*	+
Chloride	*	+
Fluoride	*	p
Magnesium	*	n
Nitrate nitrogen, as N	*	+
Phosphorus, as P	*	+
Potassium	*	n
Sodium	*	+
Sulfate	*	+

Iron, total recoverable, failed the precision criteria in the Atlanta laboratory for water year 1986, as it did in water years 1982, 1983, 1984, and 1985. In the Denver laboratory, sodium (AA); iron, total recoverable; selenium; and zinc (ICP) failed the precision criteria during water year 1986 as they did in water year 1985.

An overall evaluation of the data for water year 1986 indicates a lack of precision in results from the Atlanta laboratory for chromium, total recoverable; iron (AA); iron, total recoverable; sodium (ICP); and sodium (AA). Similar results were obtained from the Denver laboratory for calcium (AA); chloride; iron (ICP); iron, total recoverable; selenium; sodium (AA); zinc (ICP); zinc (AA); and zinc, total recoverable. Only iron, total recoverable and sodium (AA) failed the precision criteria at both laboratories..

Fewer constituents had biased data in water year 1986 than in water year 1985 at the Atlanta laboratory. For the Atlanta laboratory, constituents with negatively biased results that also were negatively biased during water year 1985 were: barium (ICP), iron (AA),manganese (ICP), and molybdenum (AA). The only constituent with positively biased results for water years 1985 and 1986 was barium, total recoverable. For the Denver laboratory, constituents with negatively biased results that also were negatively biased during water year 1985 were: barium (ICP), boron, cobalt (ICP),molybdenum (AA), and potassium; whereas, positively biased constituents consistent with results for water year 1985 were: barium (AA); barium, total recoverable; chromium; iron (AA); magnesium (ICP); selenium; silica; sodium (ICP); sulfate; zinc (ICP).

An overall evaluation of the data for water year 1986 indicates a significant bias in results from the Atlanta laboratory for aluminum; barium (ICP); barium, total recoverable; iron, (AA); manganese (ICP); molybdenum (ICP); molybdenum (AA); selenium; and silver. The evaluation of data from the Denver laboratory indicates a significant bias in results for antimony; arsenic; barium (ICP); barium (AA); barium, total recoverable; beryllium; boron; cadmium (ICP); cadmium (AA); cadmium, total recoverable; chromium; cobalt (ICP); cobalt (AA); cobalt, total recoverable; copper (ICP); copper, total recoverable; dissolved solids; fluoride;iron (ICP); iron (AA); iron, total recoverable; lead (ICP); magnesium (ICP); manganese (ICP); molybdenum (ICP); molybdenum (AA); potassium; selenium; silica; sodium (ICP); strontium; sulfate; and zinc (ICP).

Results at both laboratories for all nutrient constituents indicate acceptable precision. At the Atlanta laboratory, bias was not indicated for any of the nutrient constituents. However, the results for nitrite plus nitrate as nitrogen and nitrite as nitrogen indicated a positive bias, and results for ammonia as nitrogen indicated a negative bias at the Denver laboratory.

Due to an insufficient number of samples at the Atlanta laboratory, only precipitation data from the Denver laboratory was analyzed statistically. Results for all constituents in precipitation samples indicate acceptable precision. Results for ammonia as nitrogen, magnesium, and potassium indicate a negative bias, whereas those for fluoride indicate a positive bias.

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SUPPLEMENTAL DATA

(p. 19 follows)

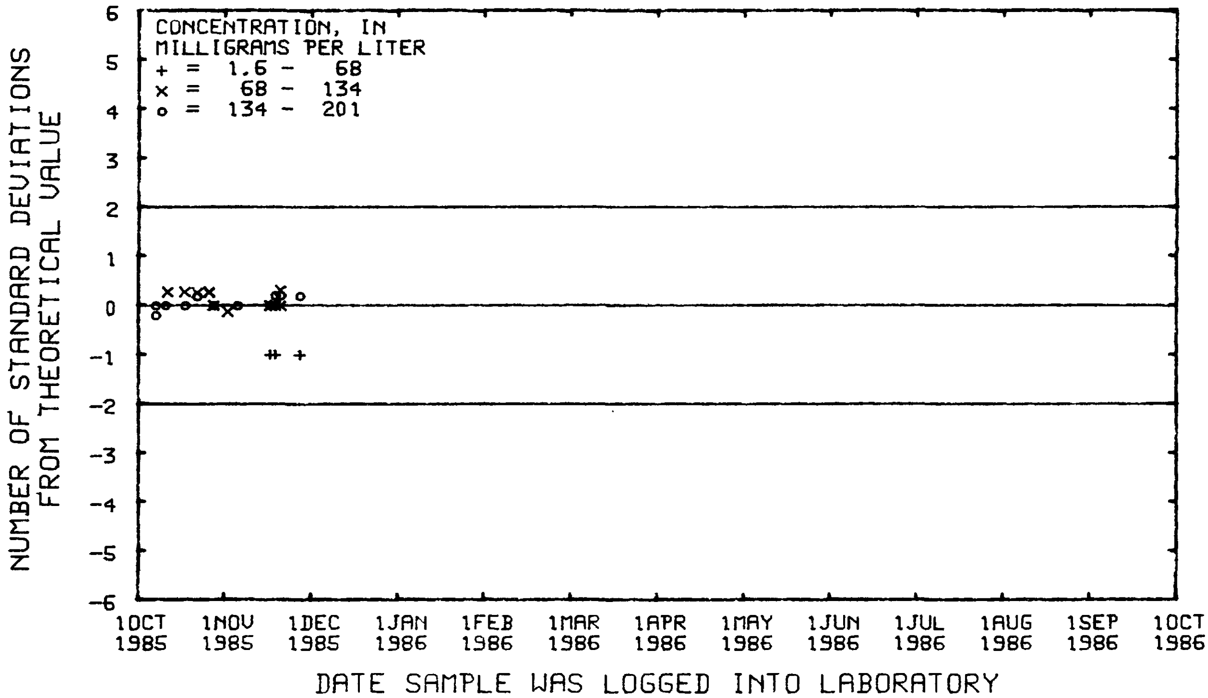


Figure 1.--Alkalinity, dissolved, data from the Atlanta laboratory.

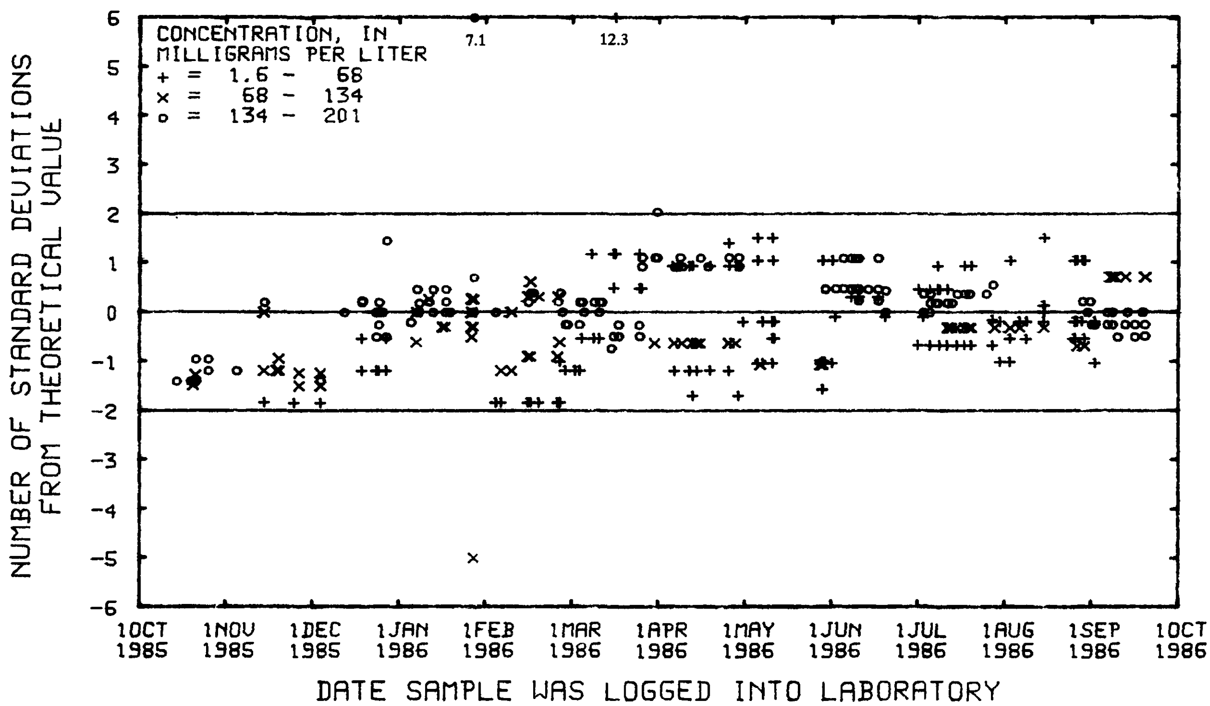


Figure 2.--Alkalinity, dissolved, data from the Denver laboratory.

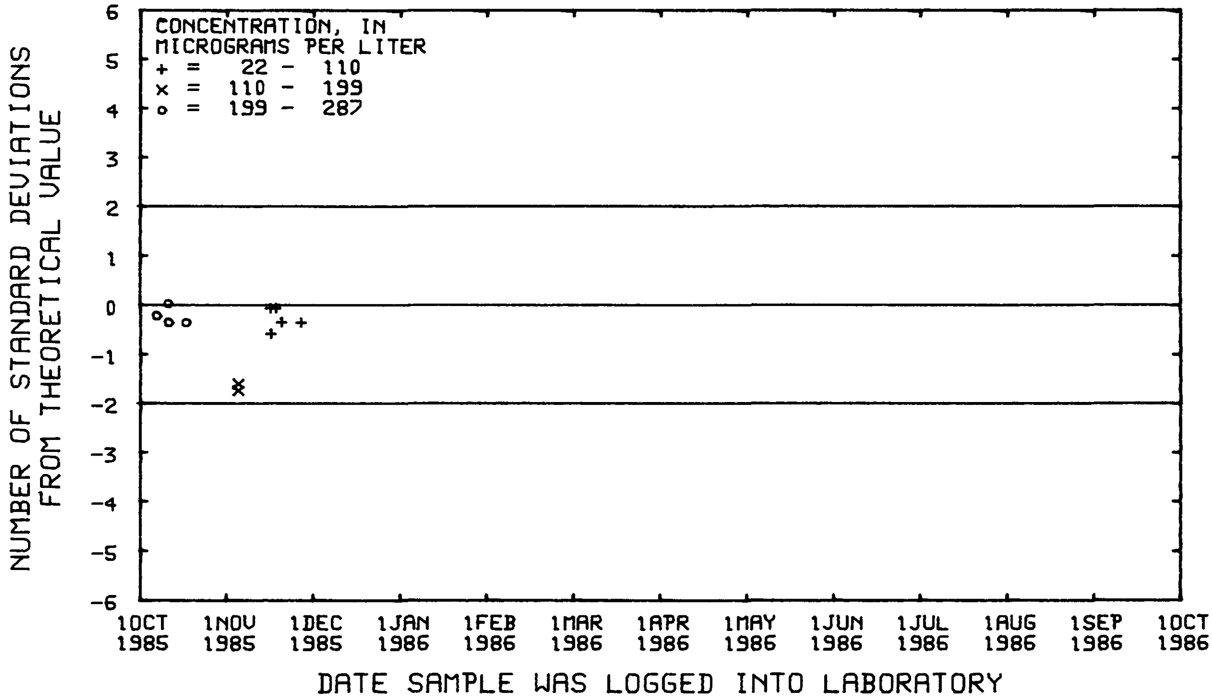


Figure 3.--Aluminum, dissolved, data from the Atlanta laboratory.

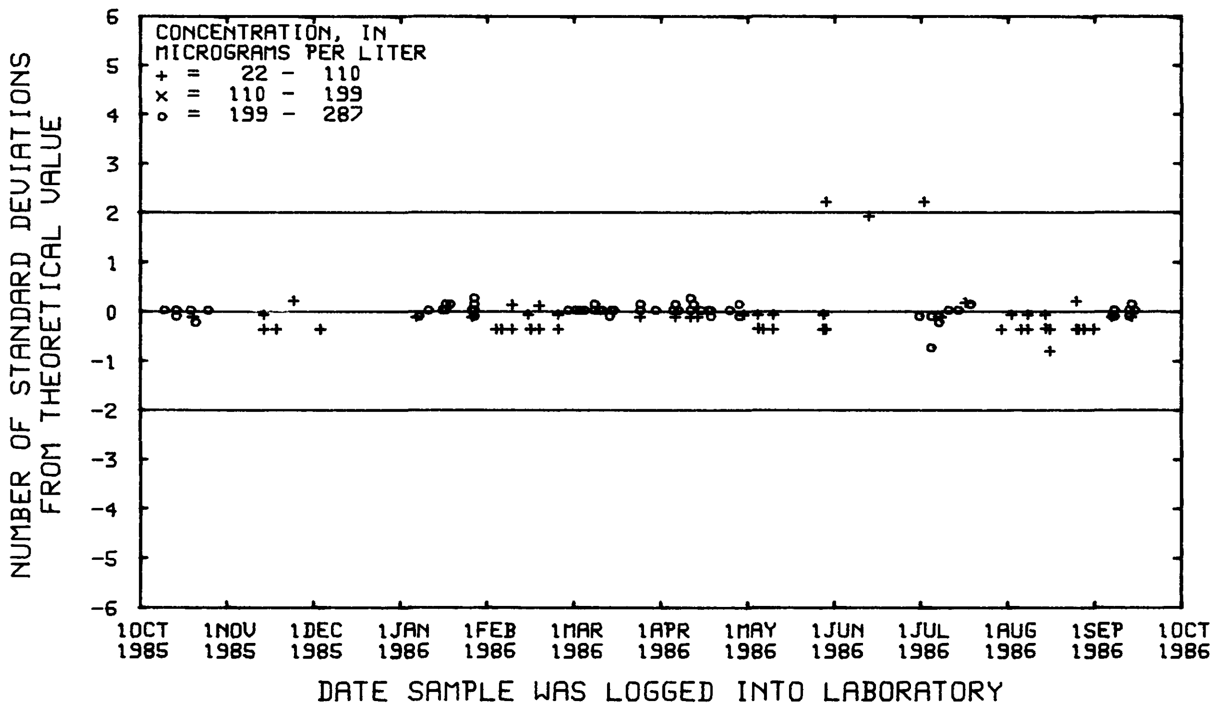


Figure 4.--Aluminum, dissolved, data from the Denver laboratory.

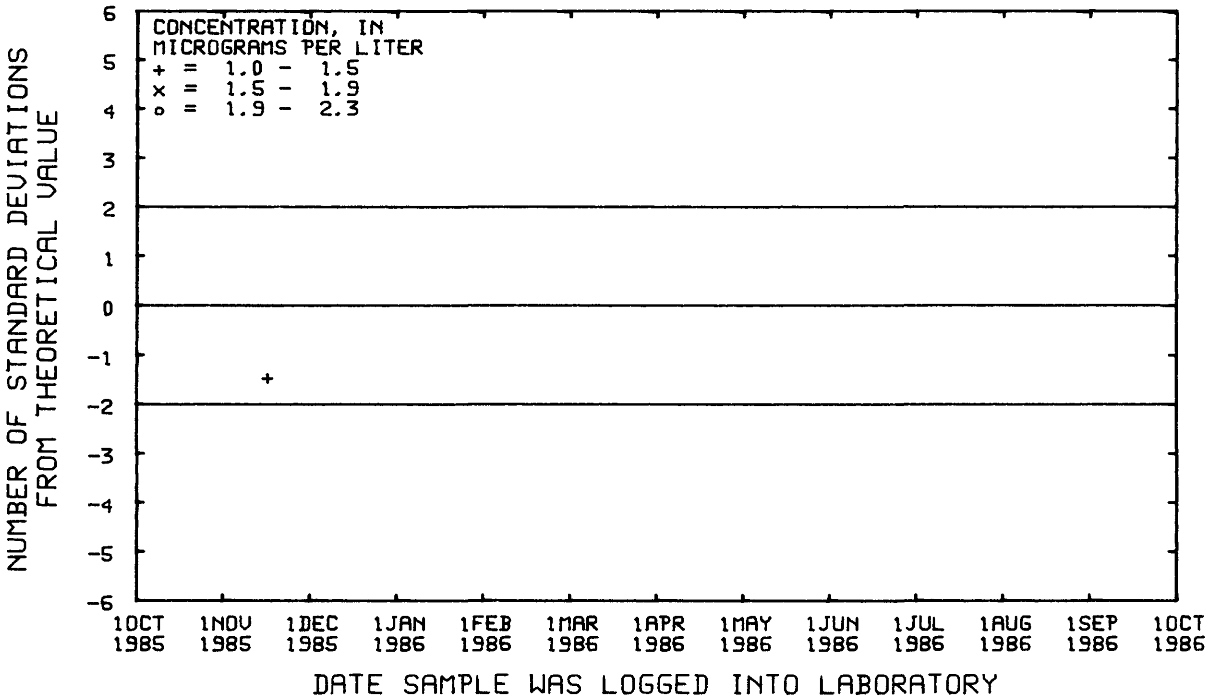


Figure 5.--Antimony, dissolved, data from the Atlanta laboratory.

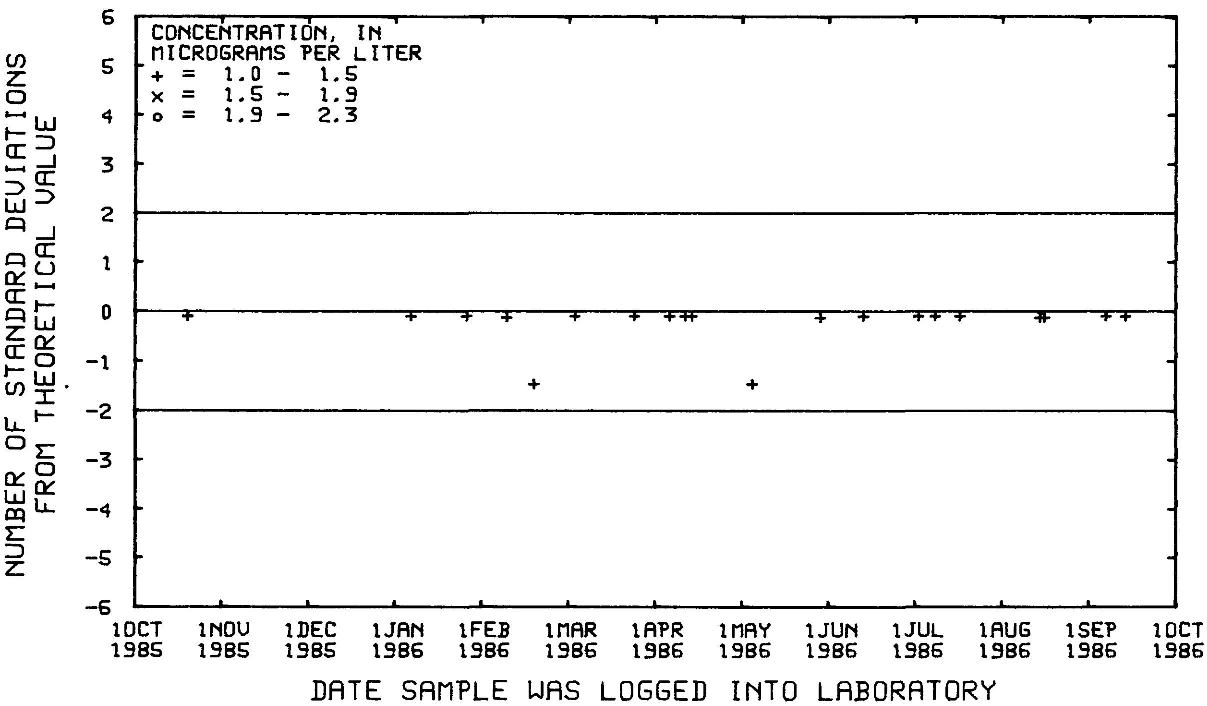


Figure 6.--Antimony, dissolved, data from the Denver laboratory.

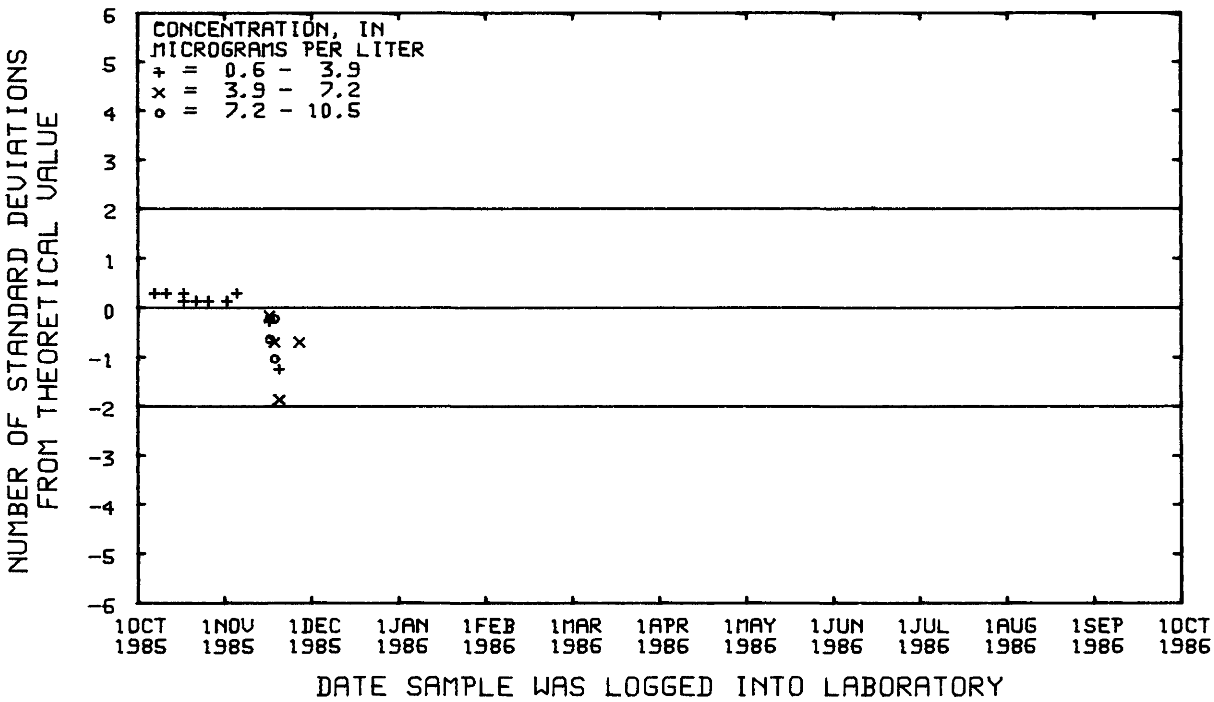


Figure 7.--Arsenic, dissolved, data from the Atlanta laboratory.

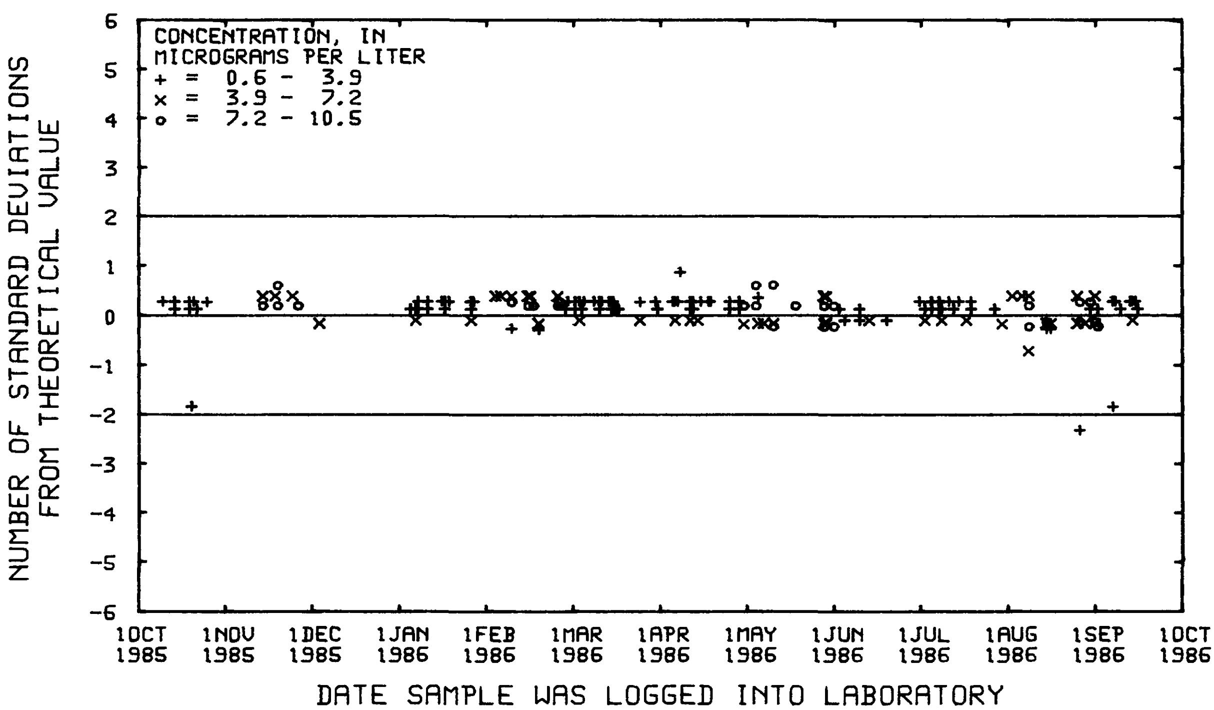


Figure 8.--Arsenic, dissolved, data from the Denver laboratory.

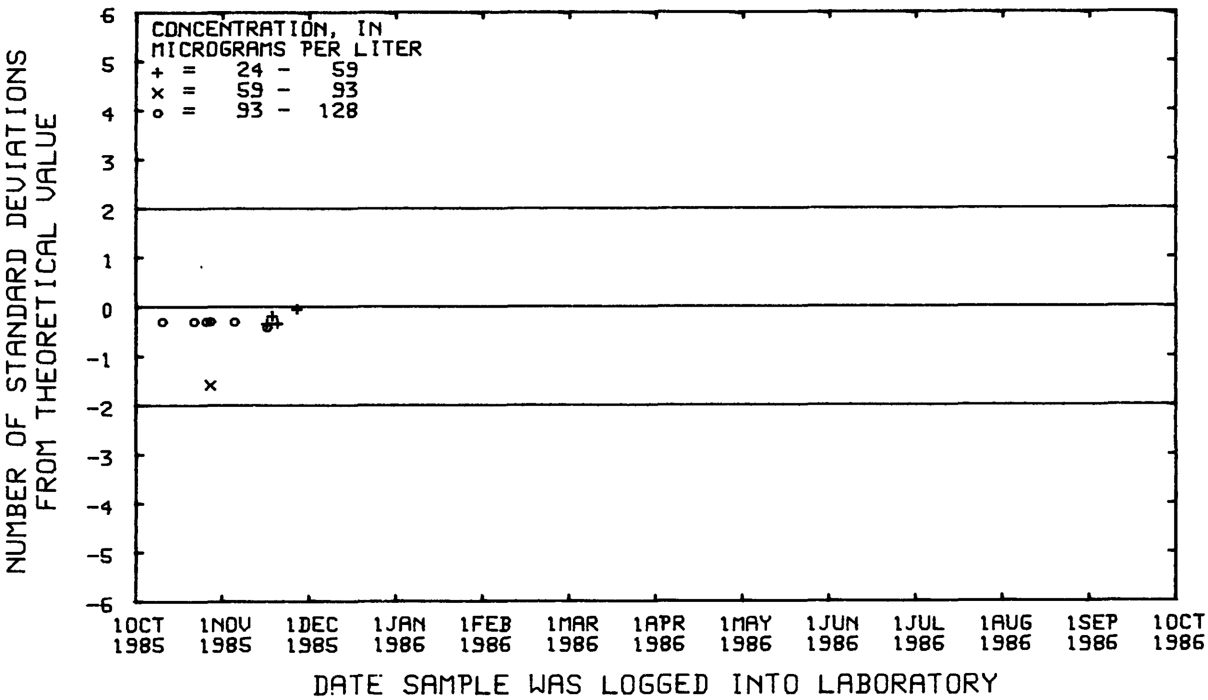


Figure 9.--Barium, dissolved,
(inductively coupled plasma emission spectrometry)
data from the Atlanta laboratory.

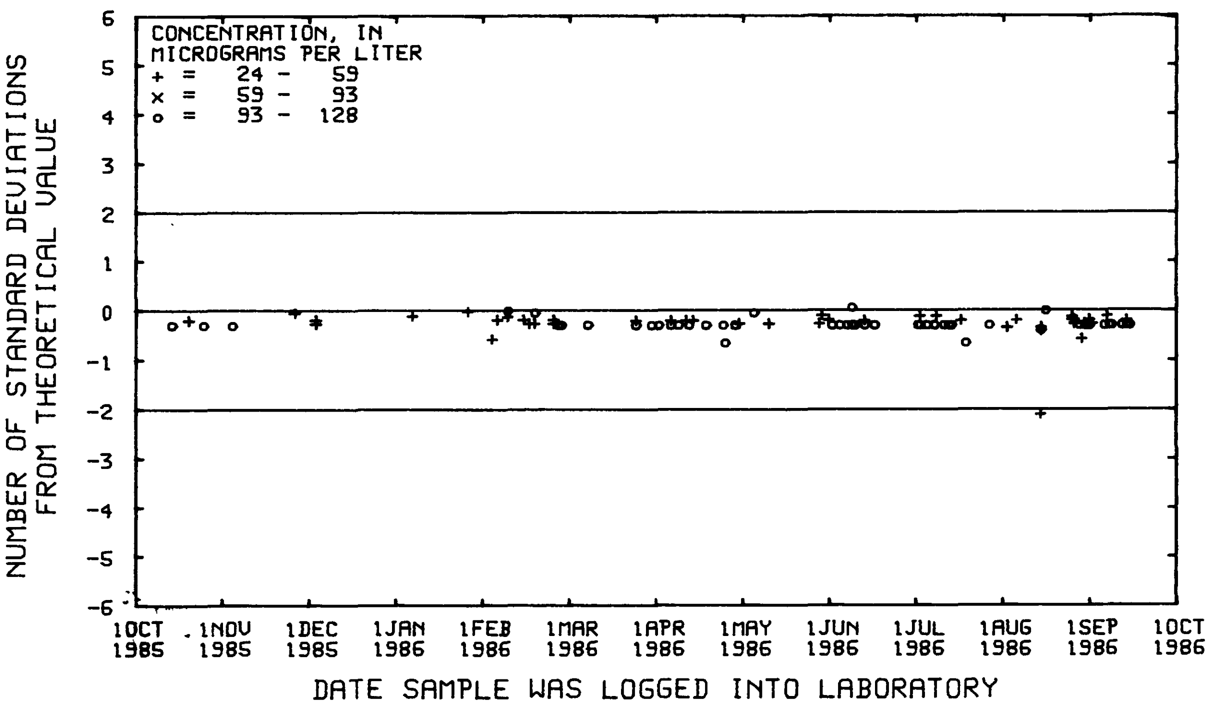


Figure 10.--Barium, dissolved,
(inductively coupled plasma emission spectrometry)
data from the Denver laboratory.

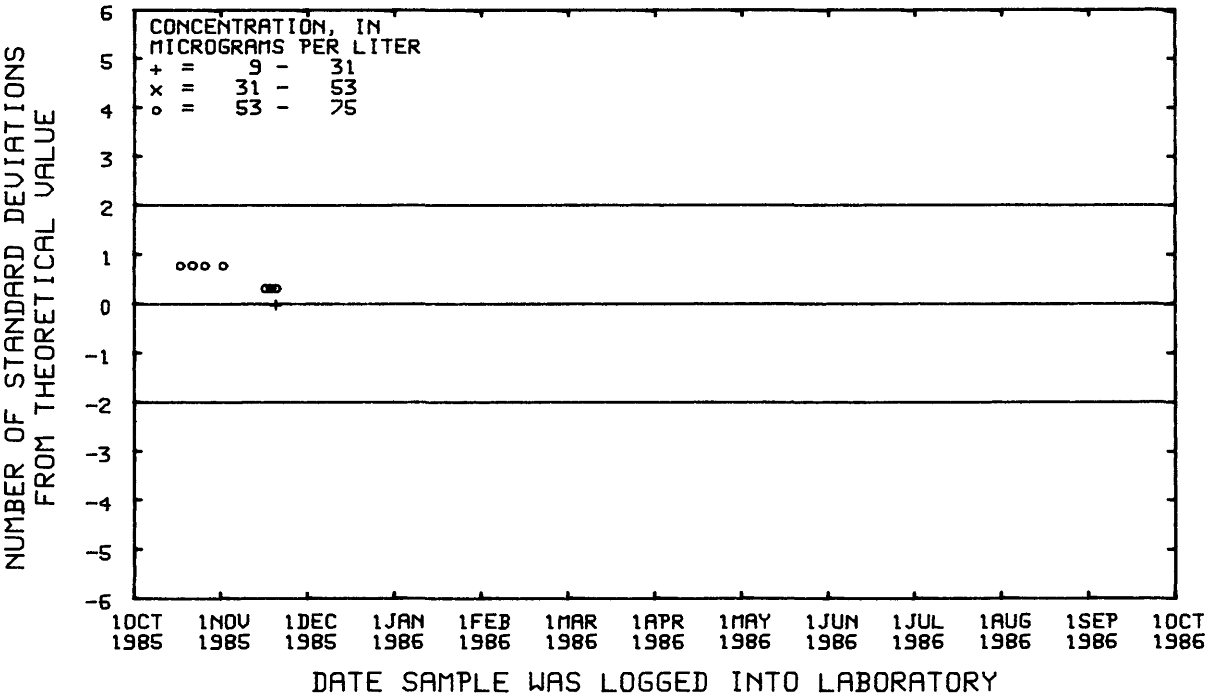


Figure 11.--Barium, dissolved, (atomic absorption spectrometry) data from the Atlanta laboratory.

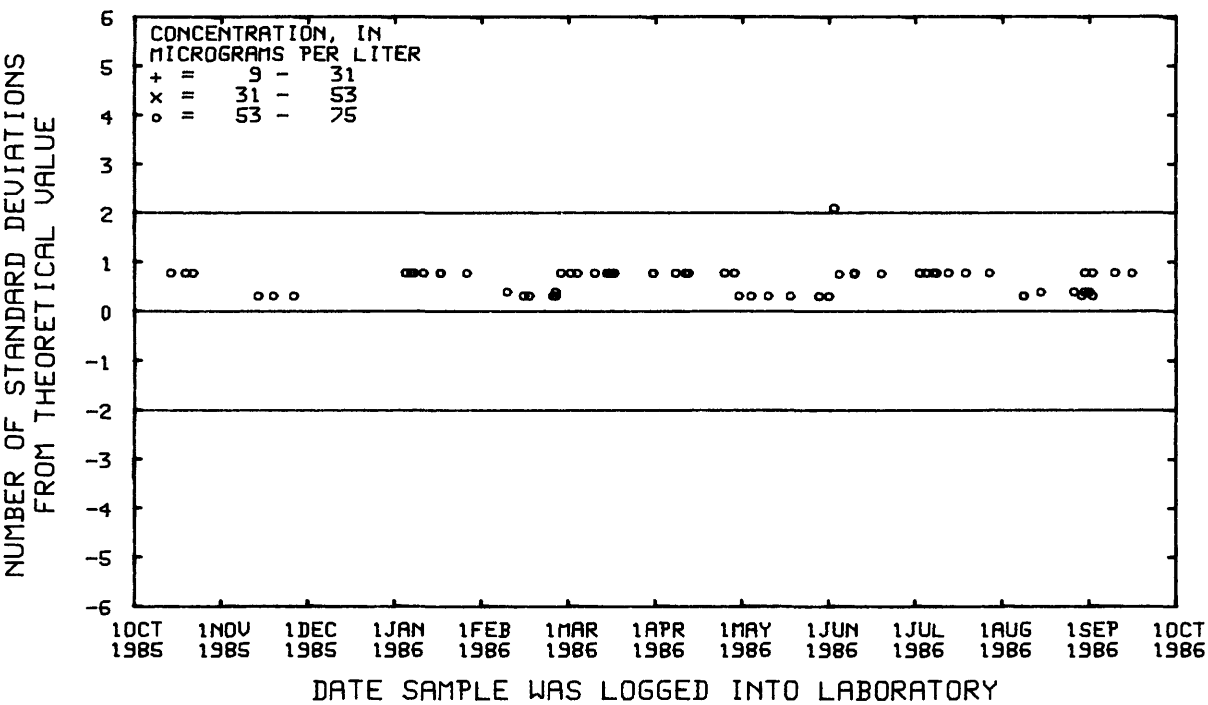


Figure 12.--Barium, dissolved, (atomic absorption spectrometry) data from the Denver laboratory.

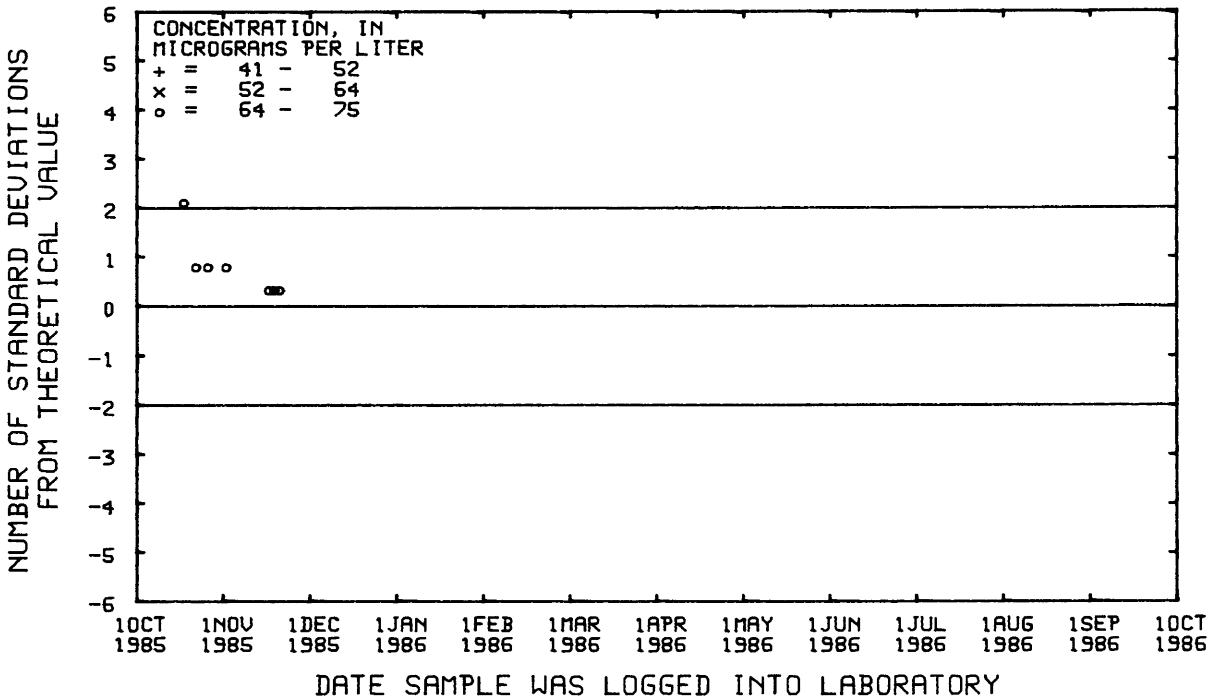


Figure 13.--Barium, total recoverable, data from the Atlanta laboratory.

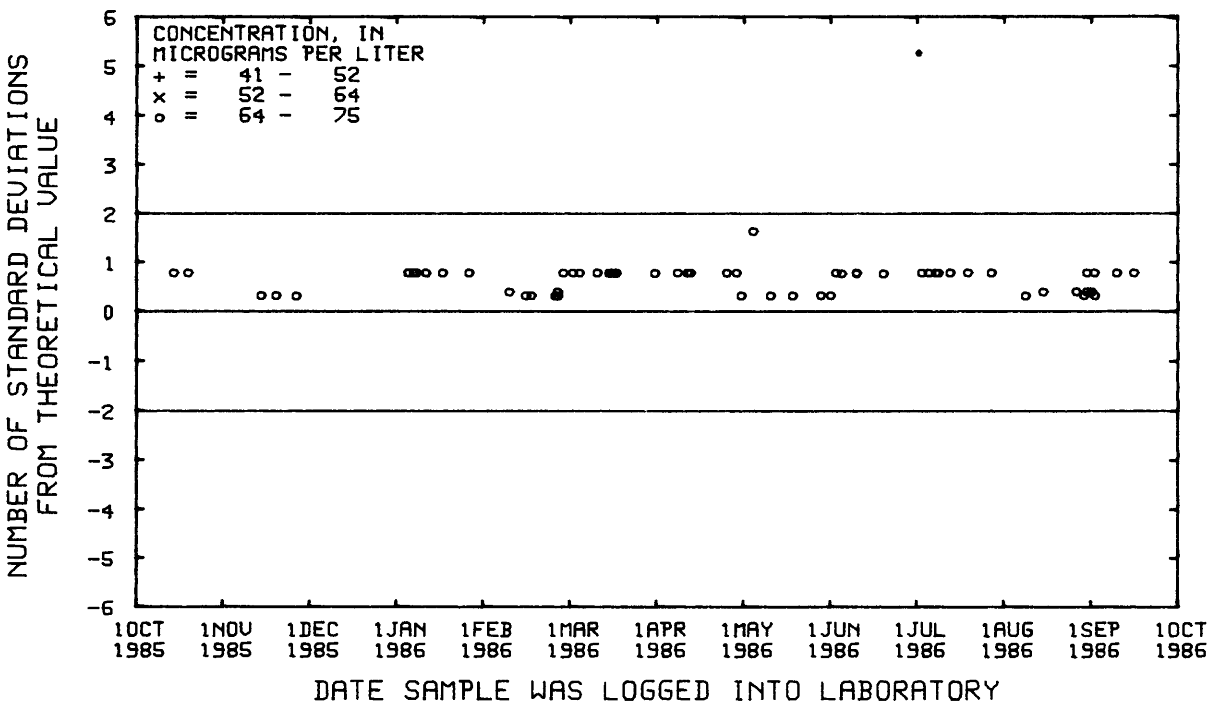


Figure 14.--Barium, total recoverable, data from the Denver laboratory.

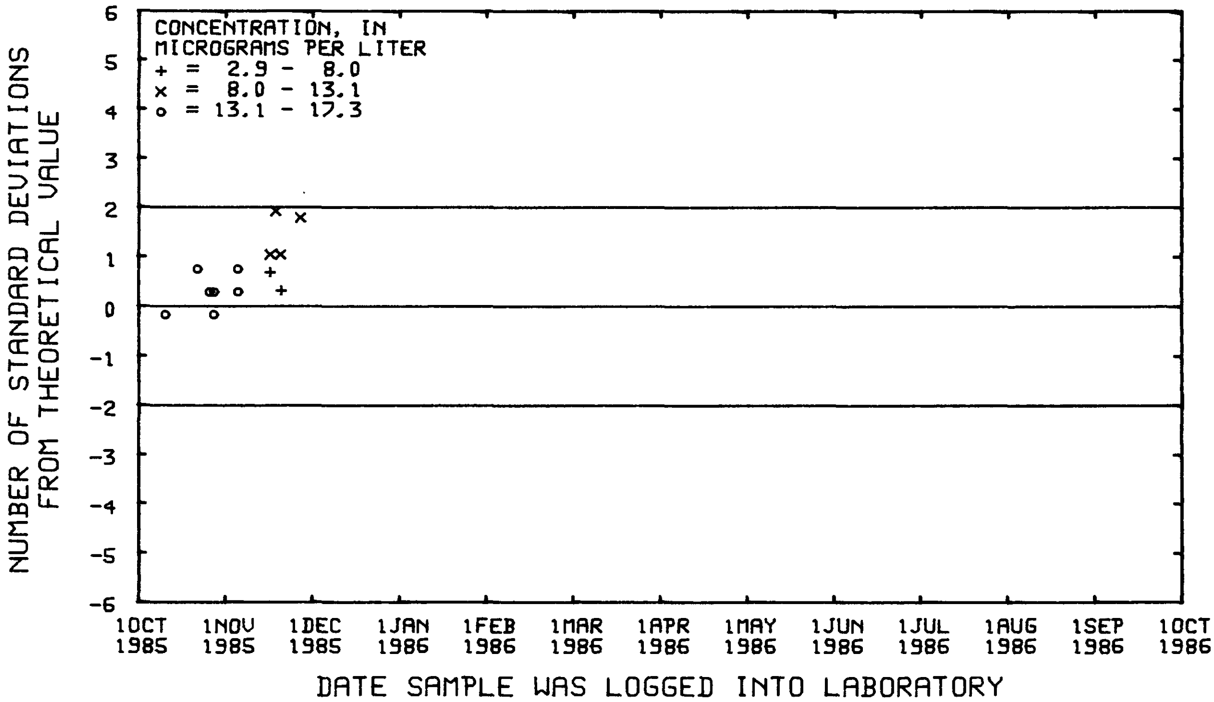


Figure 15.--Beryllium, dissolved, data from the Atlanta laboratory

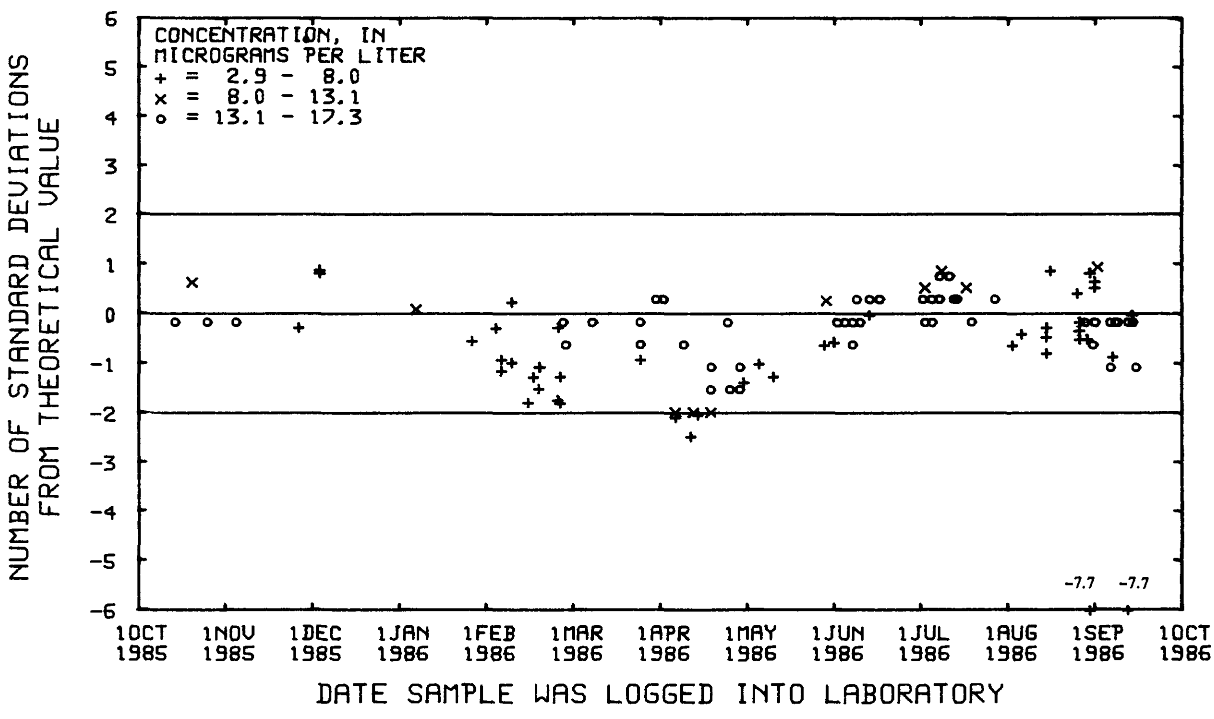


Figure 16.--Beryllium, dissolved, data from the Denver laboratory.

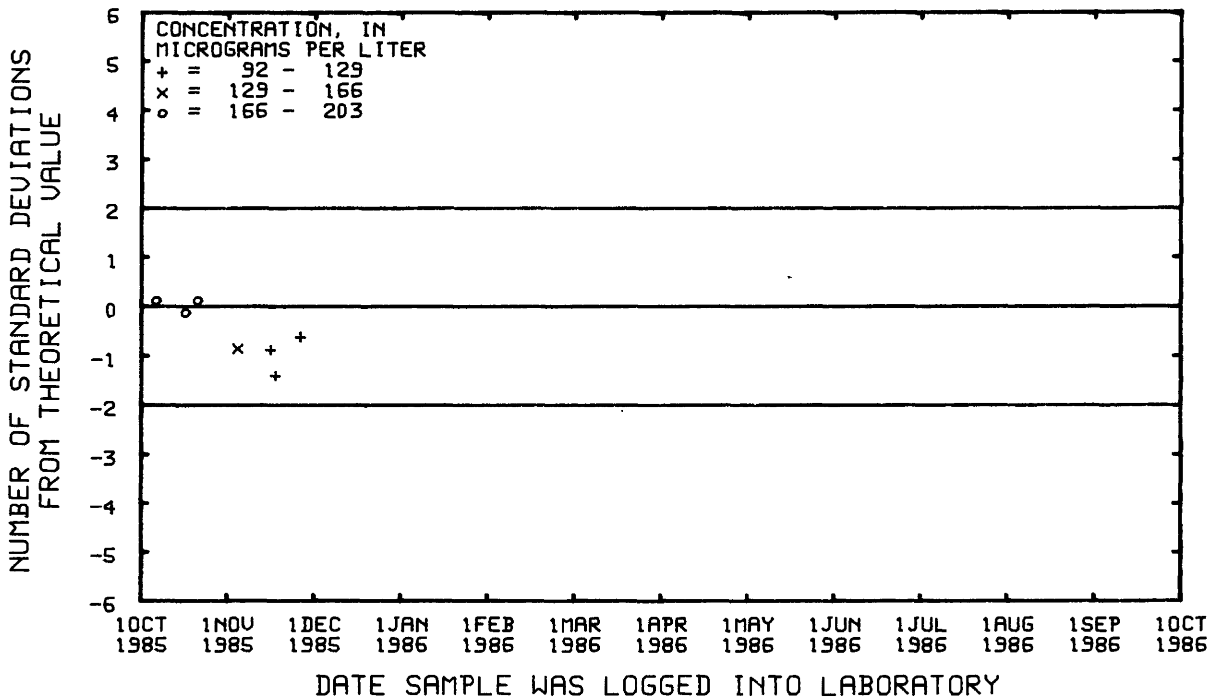


Figure 17.--Boron, dissolved, data from the Atlanta laboratory.

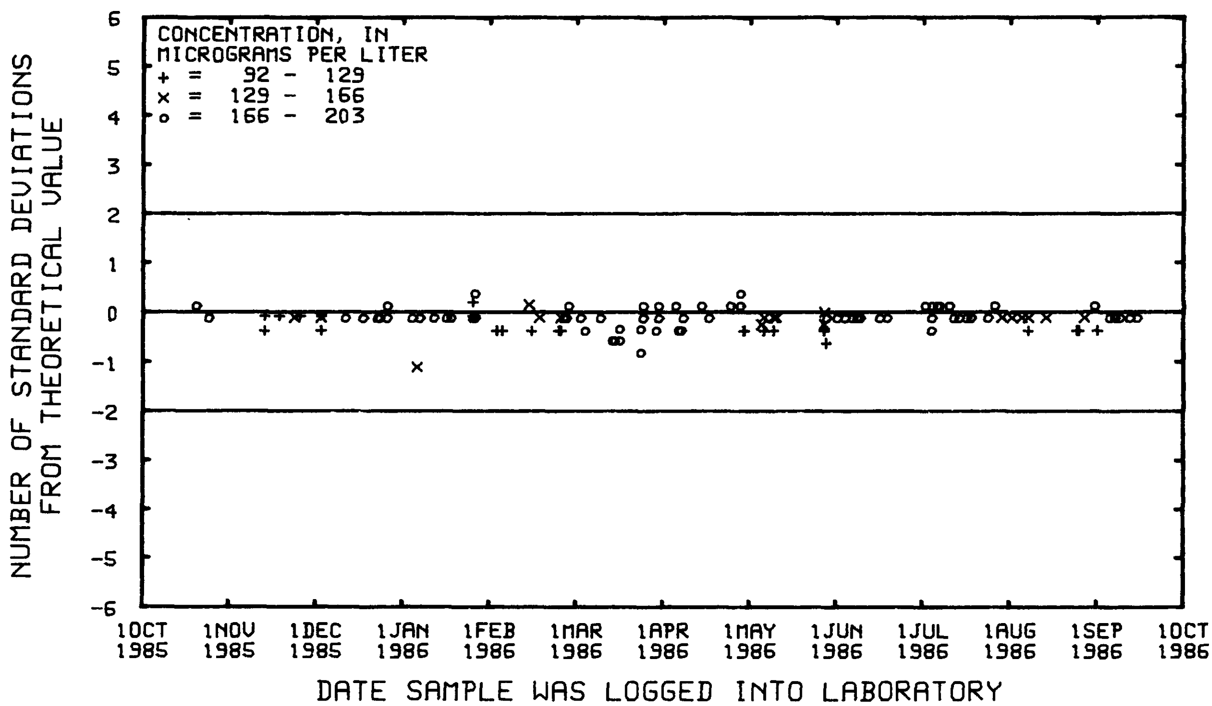


Figure 18.--Boron, dissolved, data from the Denver laboratory.

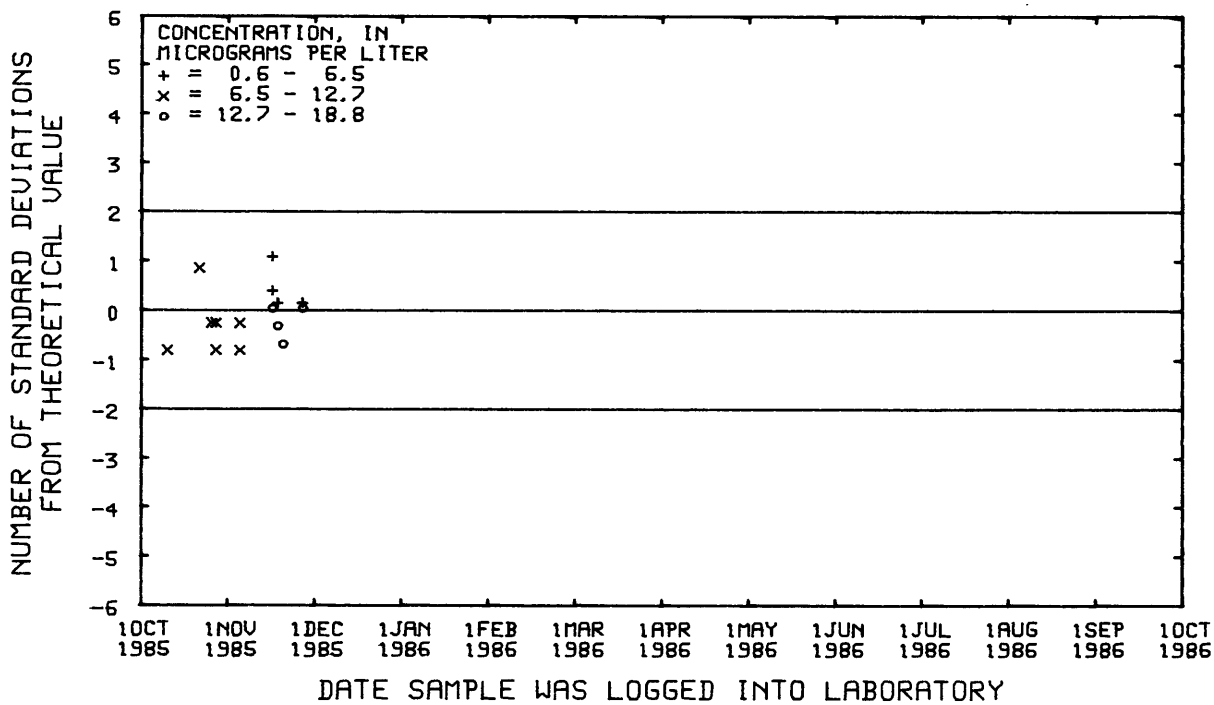


Figure 19.--Cadmium, dissolved, (inductively coupled plasma emission spectrometry) data from the Atlanta laboratory.

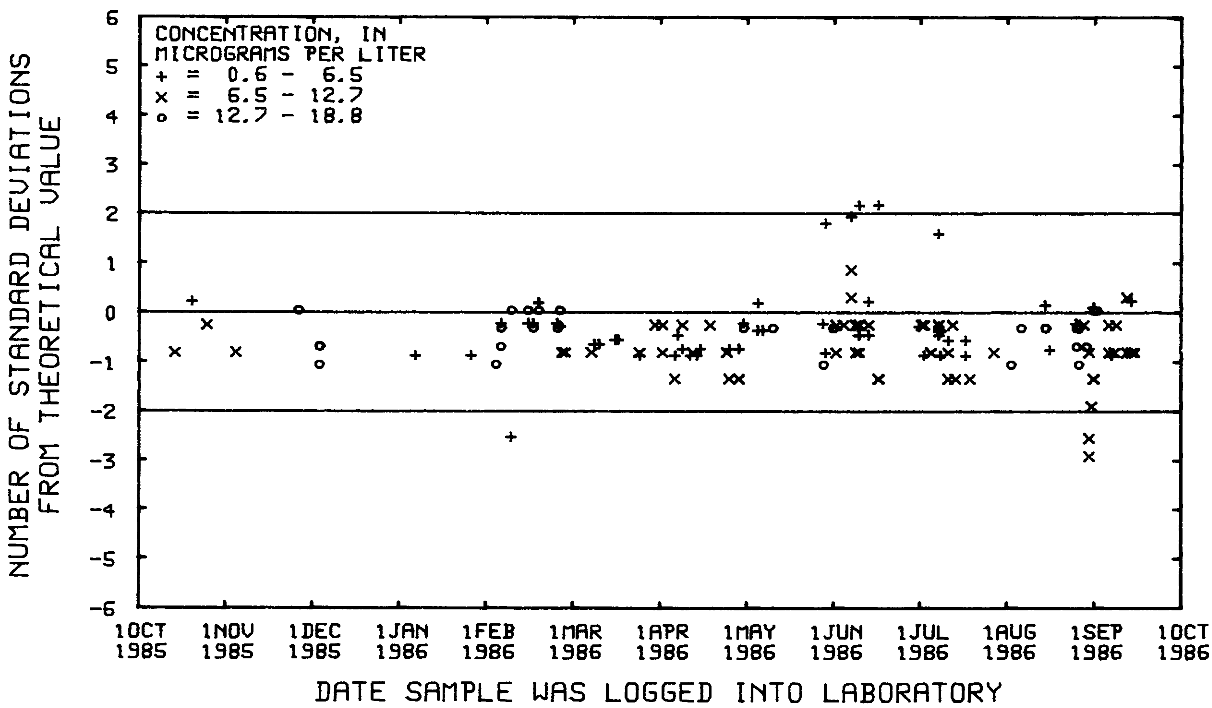


Figure 20.--Cadmium, dissolved, (inductively coupled plasma emission spectrometry) data from the Denver laboratory.

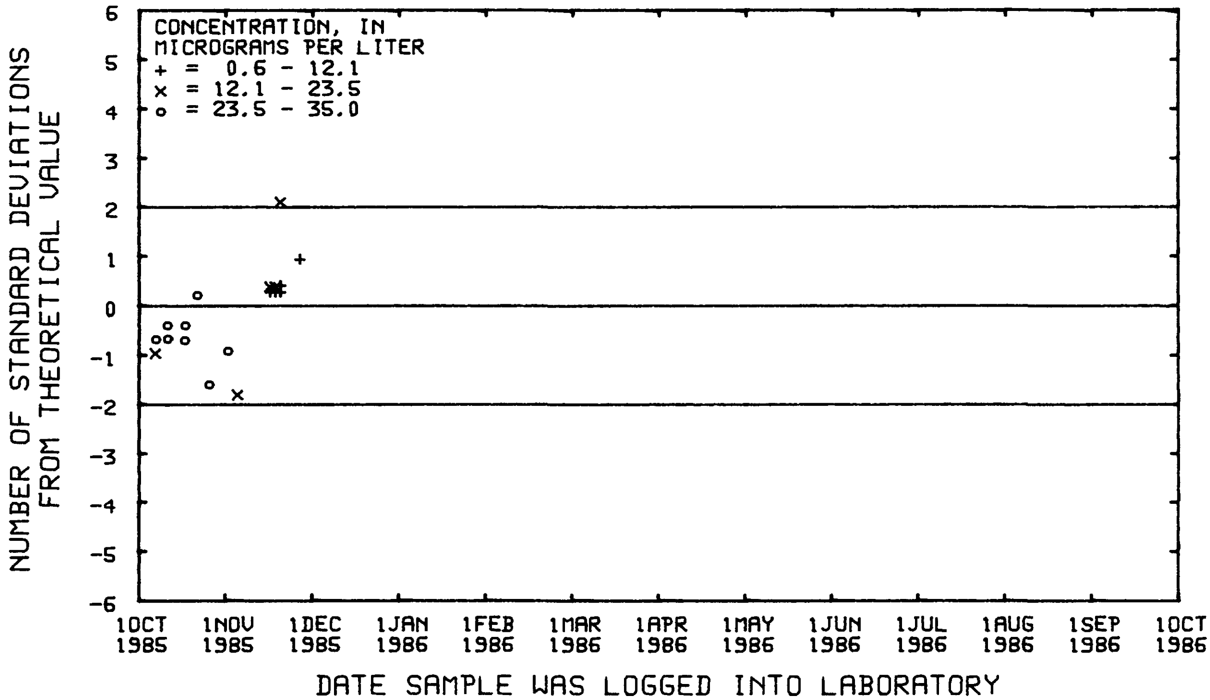


Figure 21.--Cadmium, dissolved,
(atomic absorption spectrometry)
data from the Atlanta laboratory.

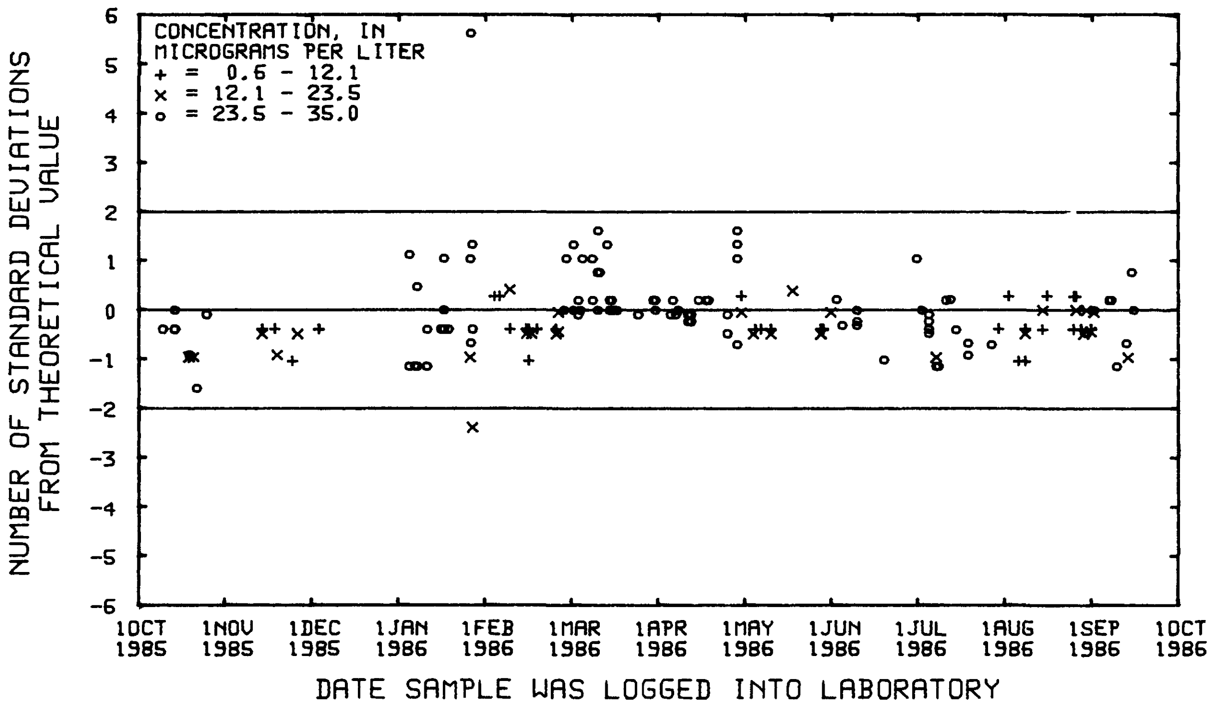


Figure 22.--Cadmium, dissolved,
(atomic absorption spectrometry)
data from the Denver laboratory.

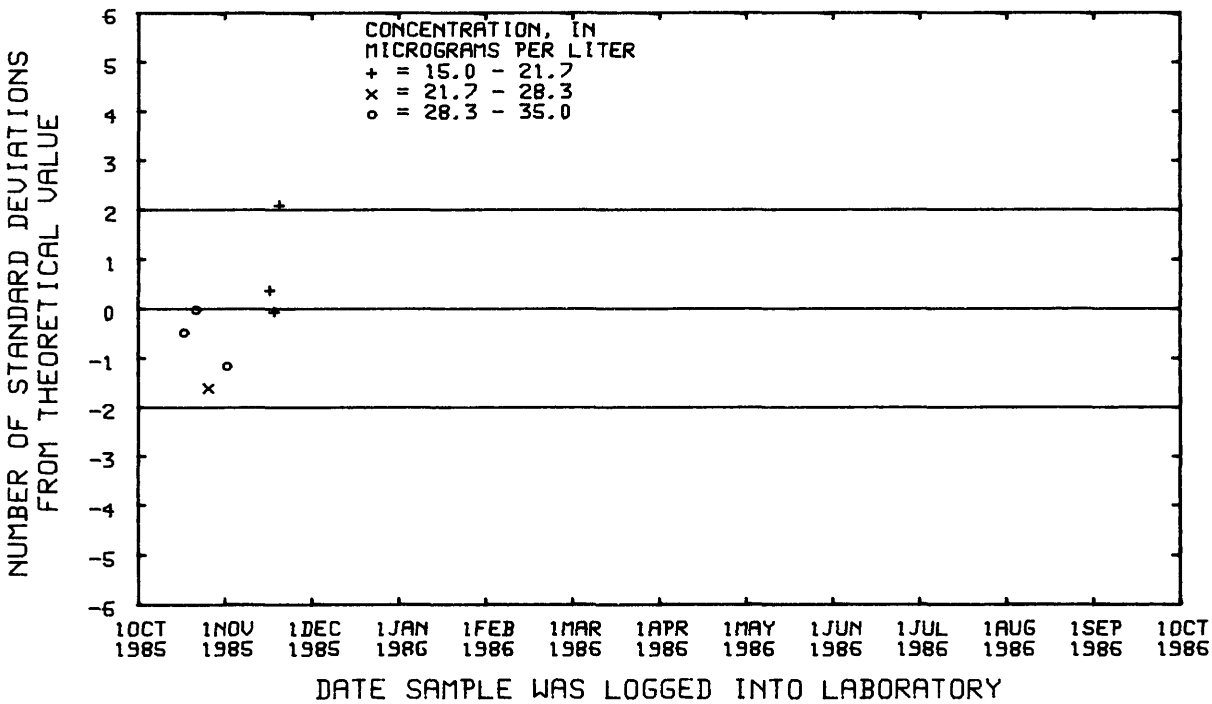


Figure 23.--Cadmium, total recoverable, data from the Atlanta laboratory.

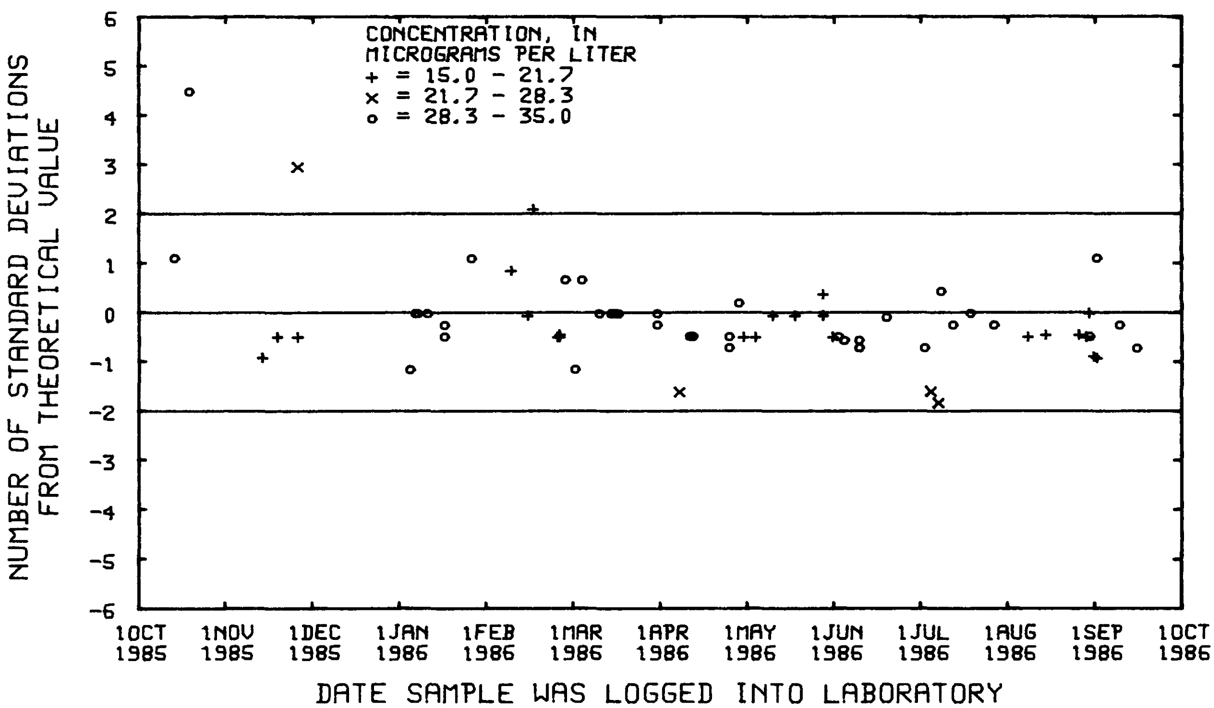


Figure 24.--Cadmium, total recoverable, data from the Denver laboratory.

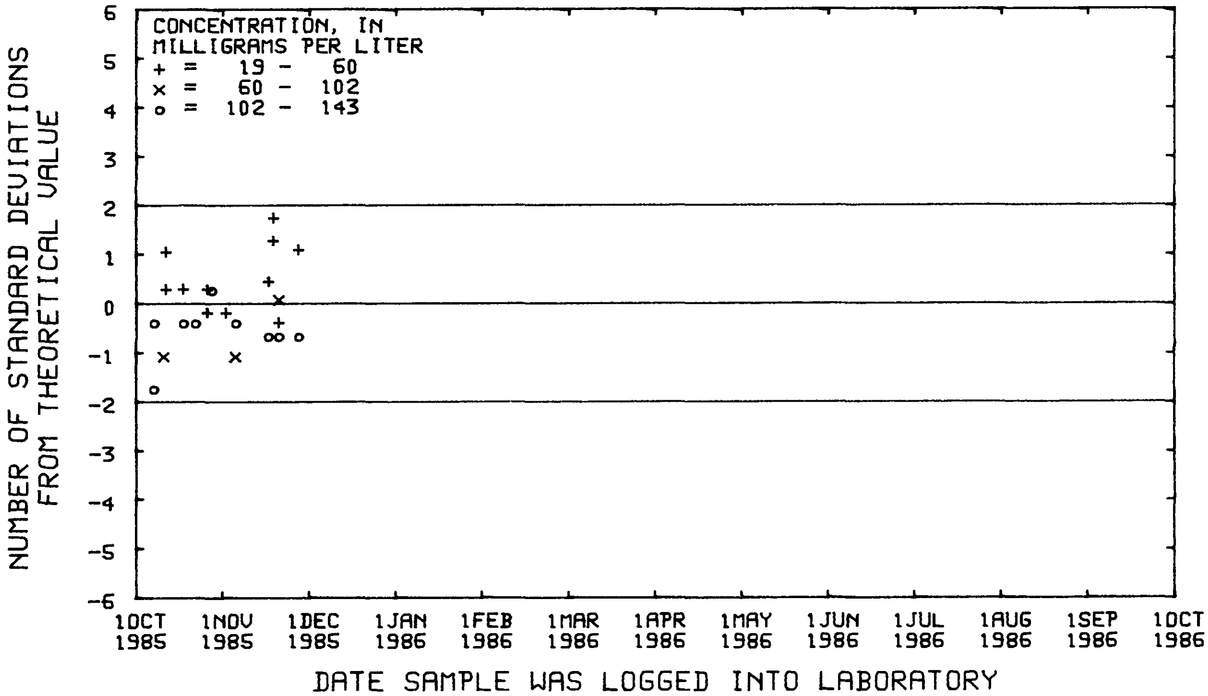


Figure 25.--Calcium, dissolved,
(inductively coupled plasma emission spectrometry)
data from the Atlanta laboratory.

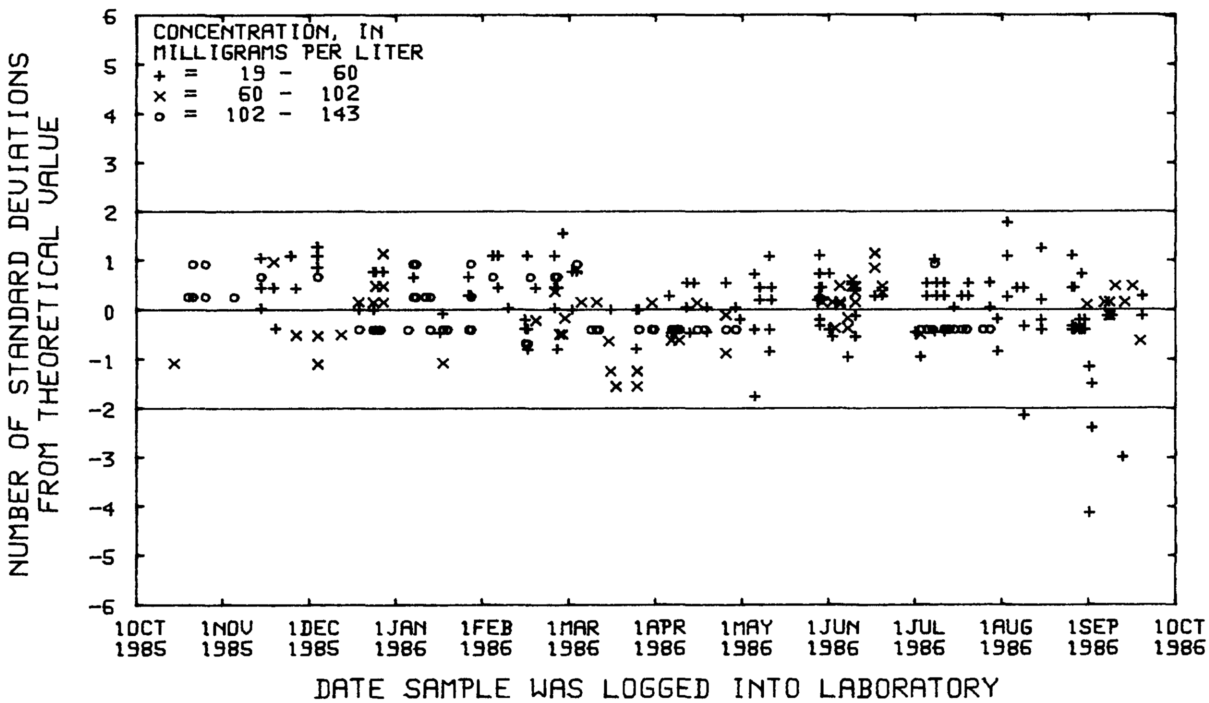


Figure 26.--Calcium, dissolved,
(inductively coupled plasma emission spectrometry)
data from the Denver laboratory.

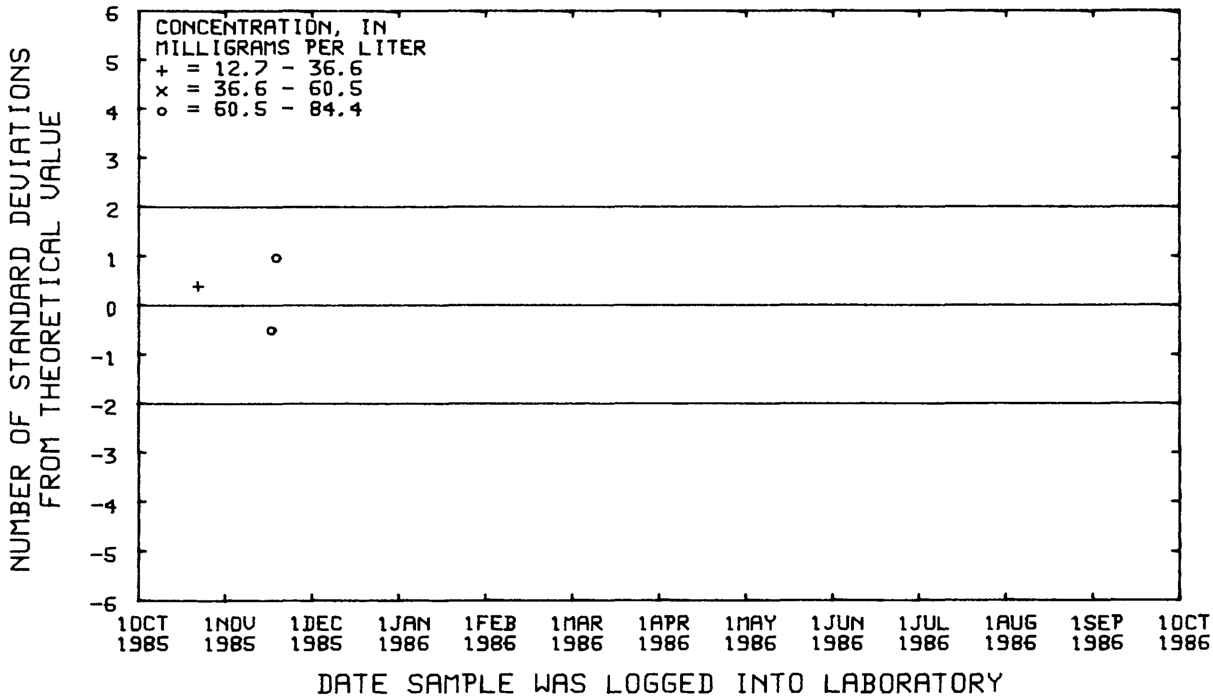


Figure 27.--Calcium, dissolved, (atomic absorption spectrometry) data from the Atlanta laboratory.

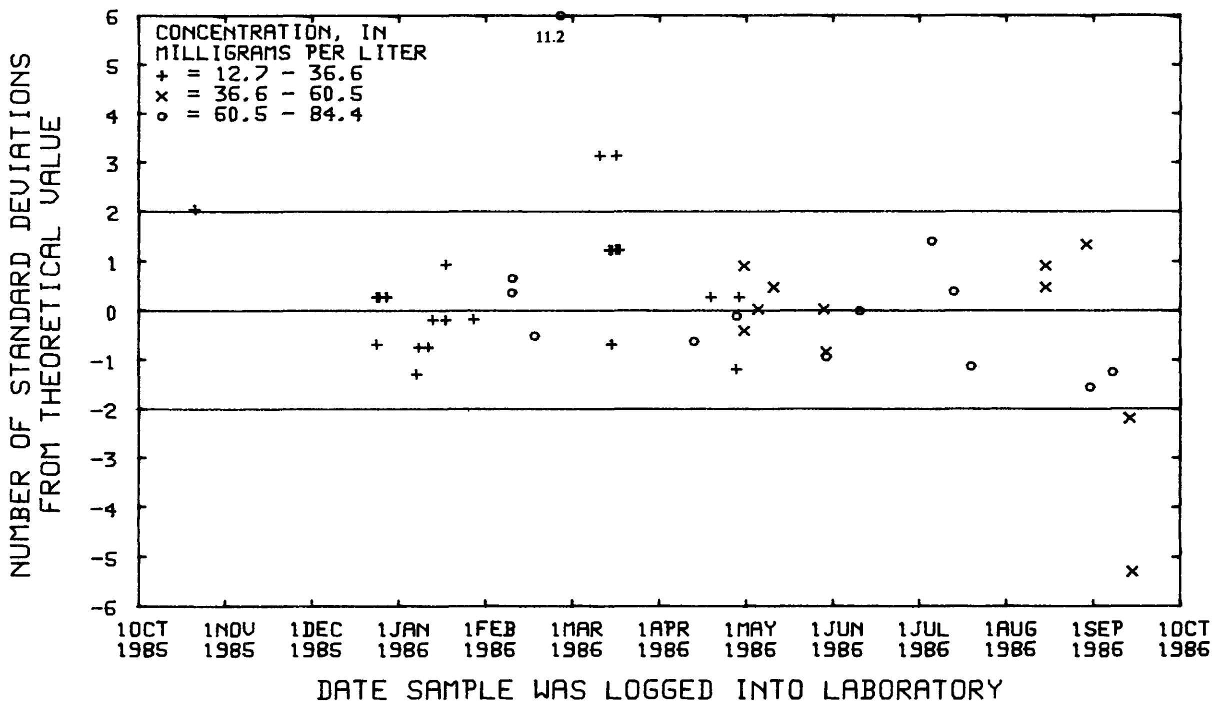


Figure 28.--Calcium, dissolved, (atomic absorption spectrometry) data from the Denver laboratory.

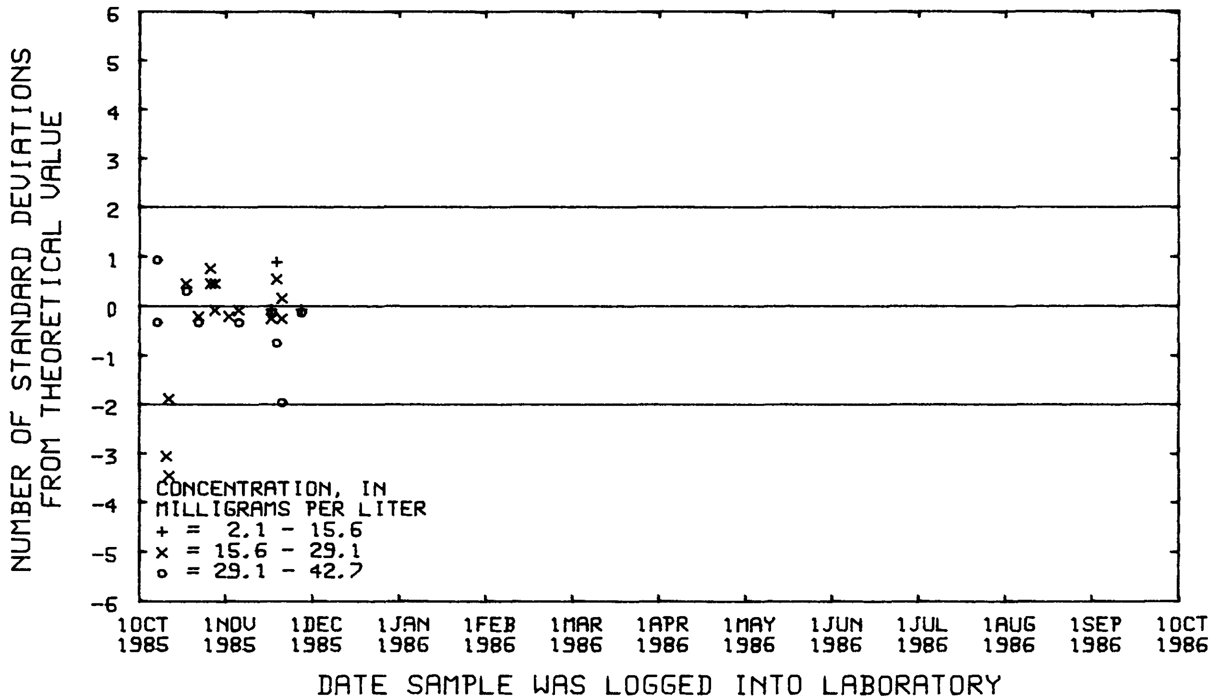


Figure 29.--Chloride, dissolved, data from the Atlanta laboratory.

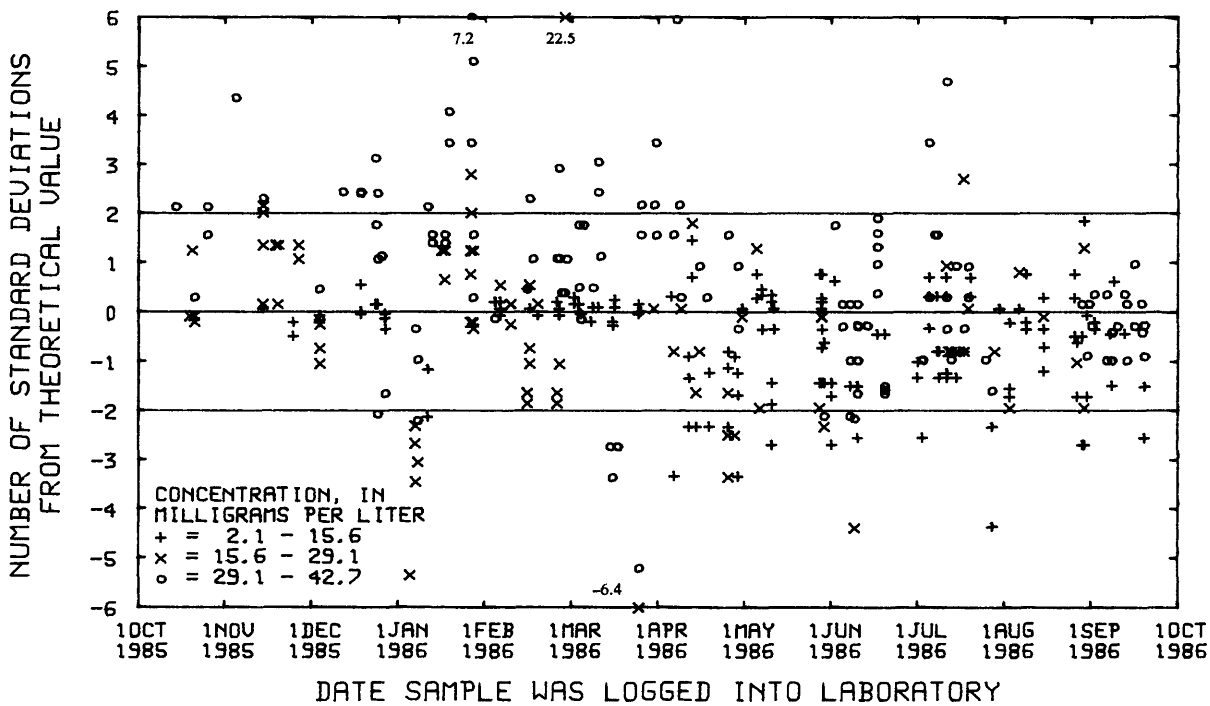


Figure 30.--Chloride, dissolved, data from the Denver laboratory.

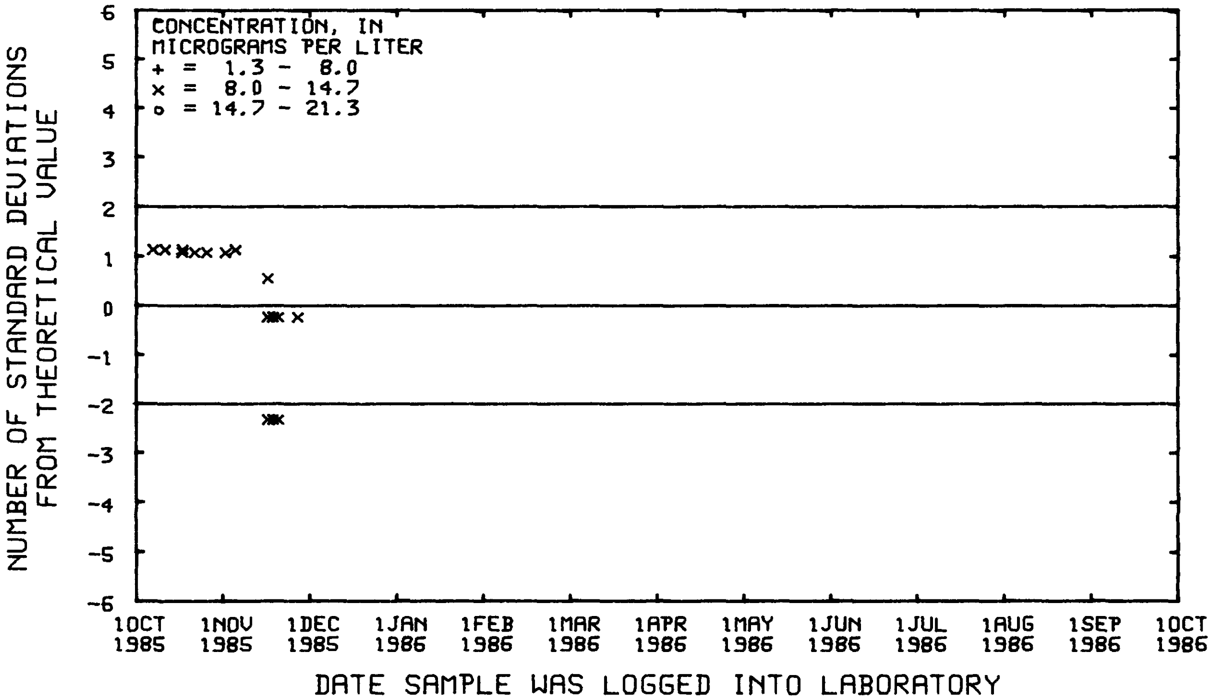


Figure 31.--Chromium, dissolved, data from the Atlanta laboratory.

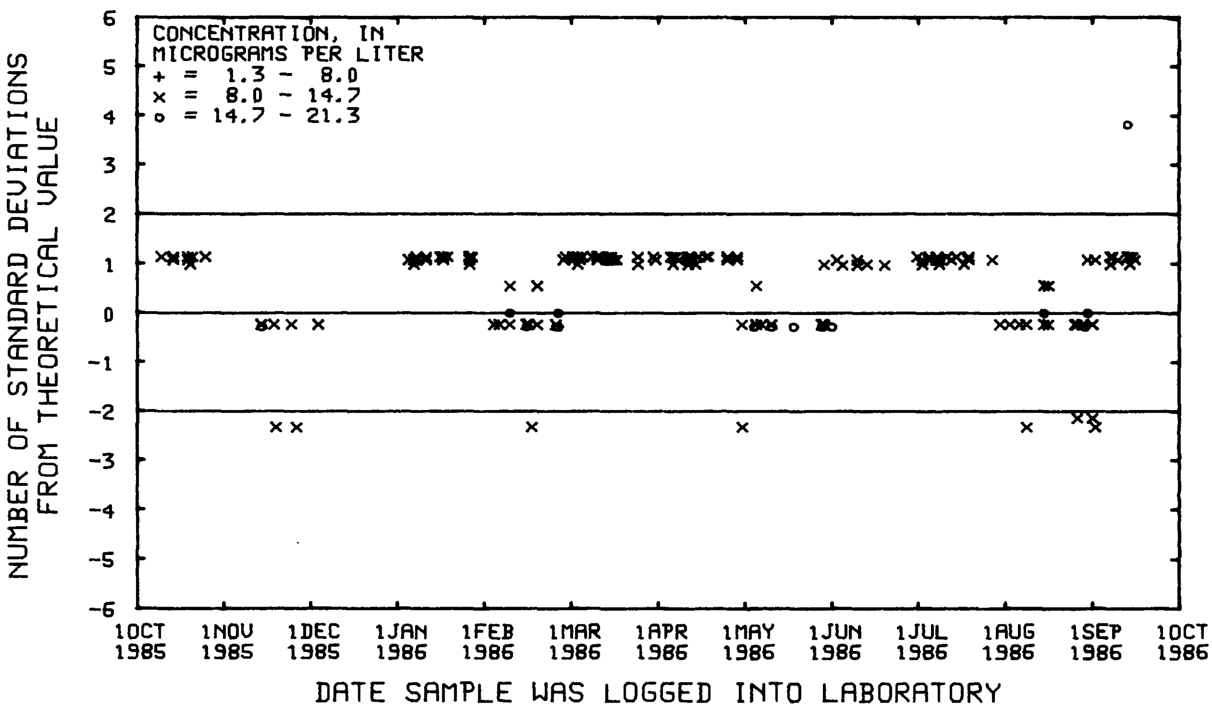


Figure 32.--Chromium, dissolved, data from the Denver laboratory.

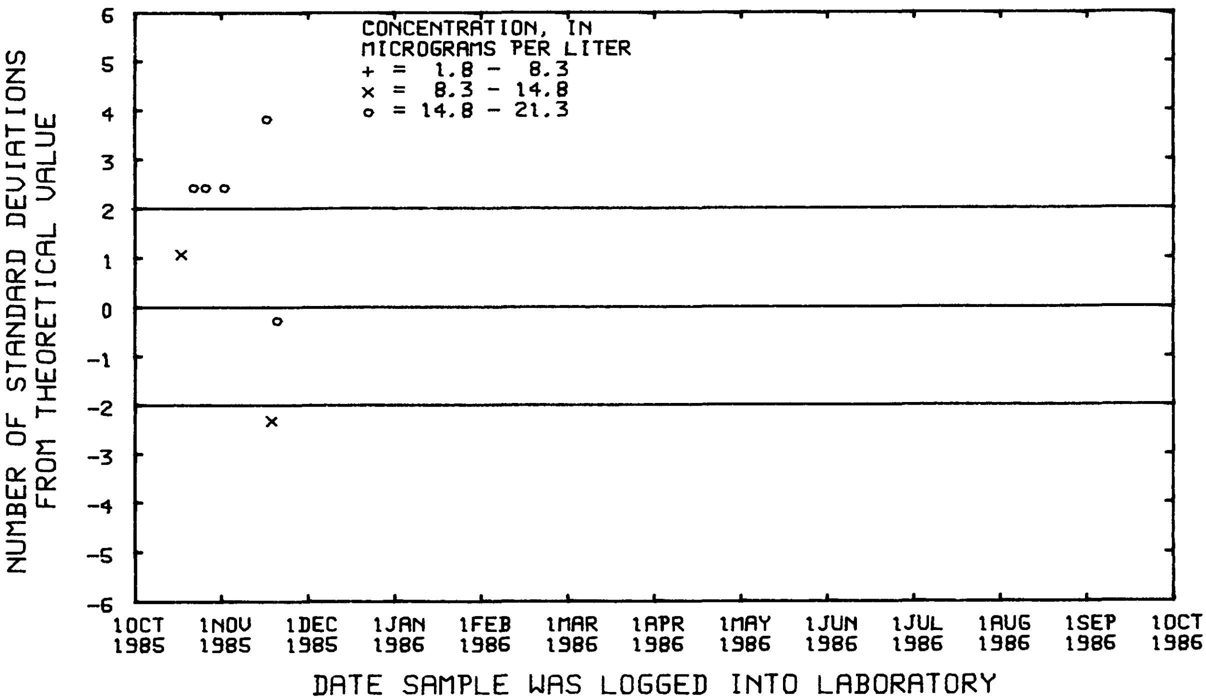


Figure 33.--Chromium, total recoverable, data from the Atlanta laboratory.

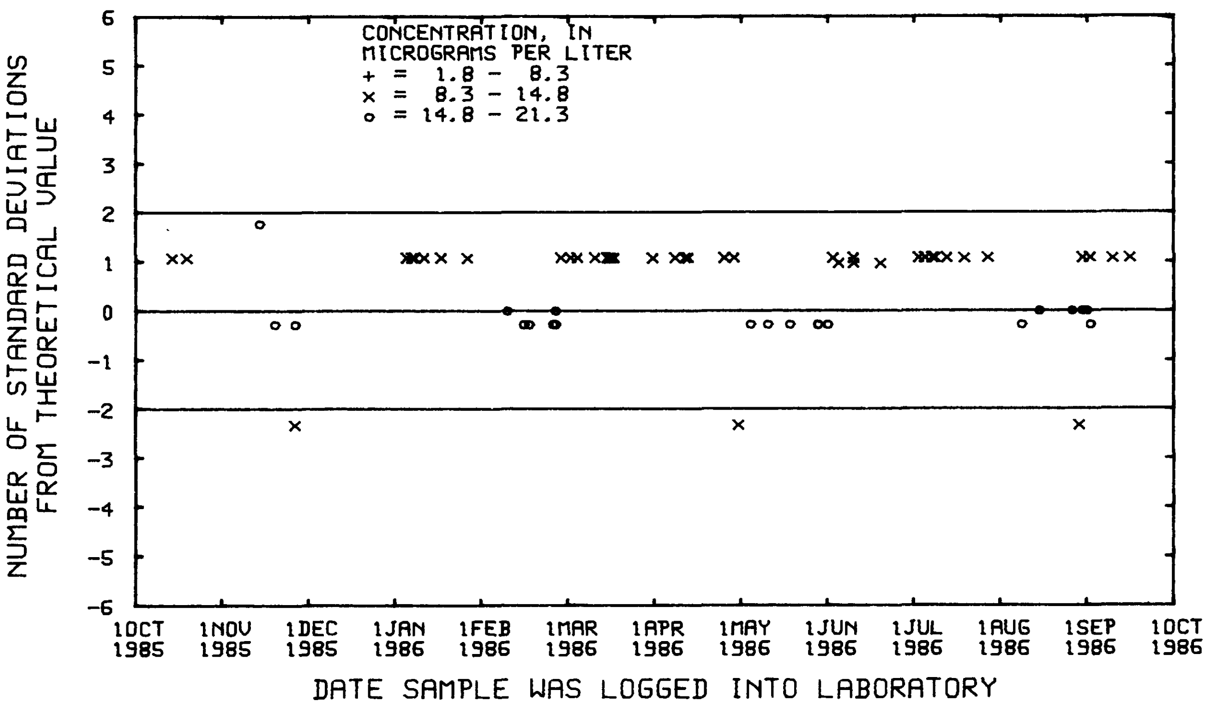


Figure 34.--Chromium, total recoverable, data from the Denver laboratory.

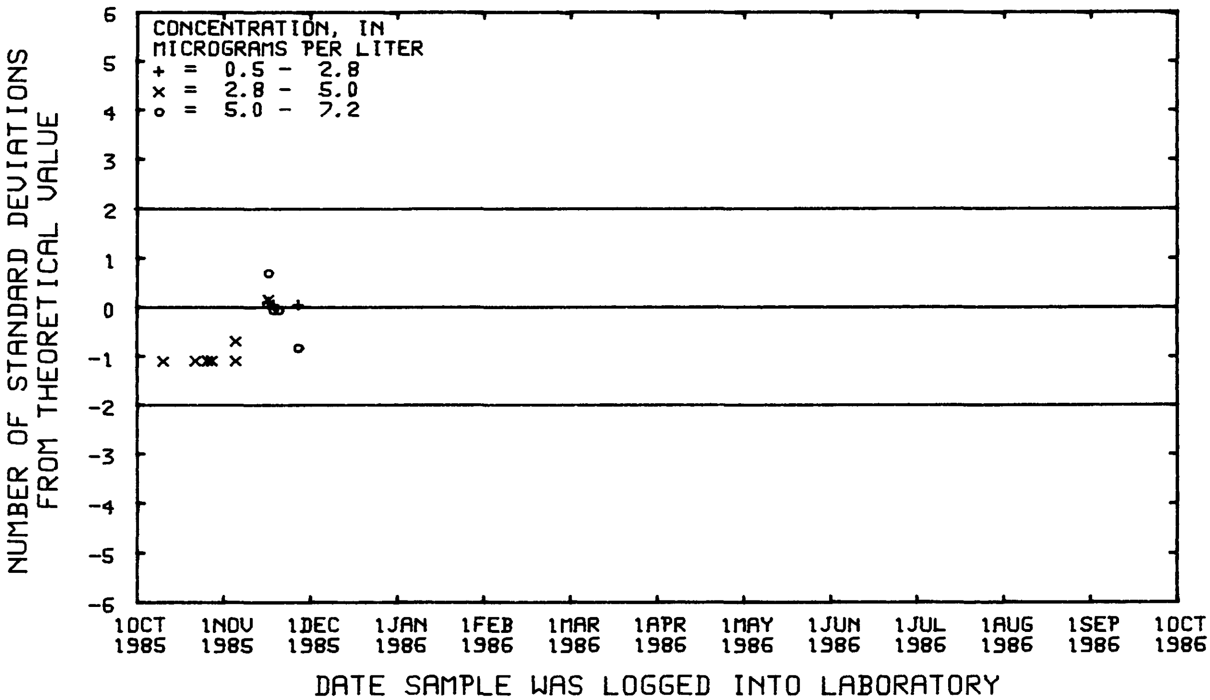


Figure 35.--Cobalt, dissolved,
(inductively coupled plasma emission spectrometry)
data from the Atlanta laboratory.

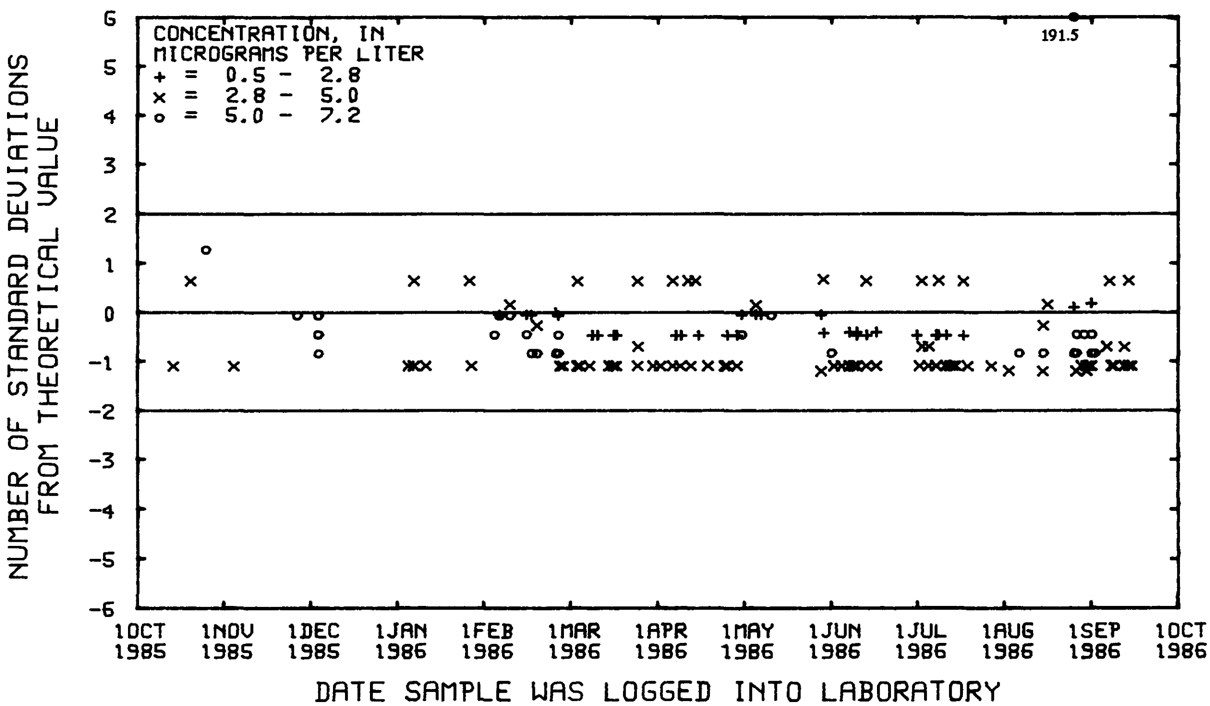


Figure 36.--Cobalt, dissolved,
(inductively coupled plasma emission spectrometry)
data from the Denver laboratory.

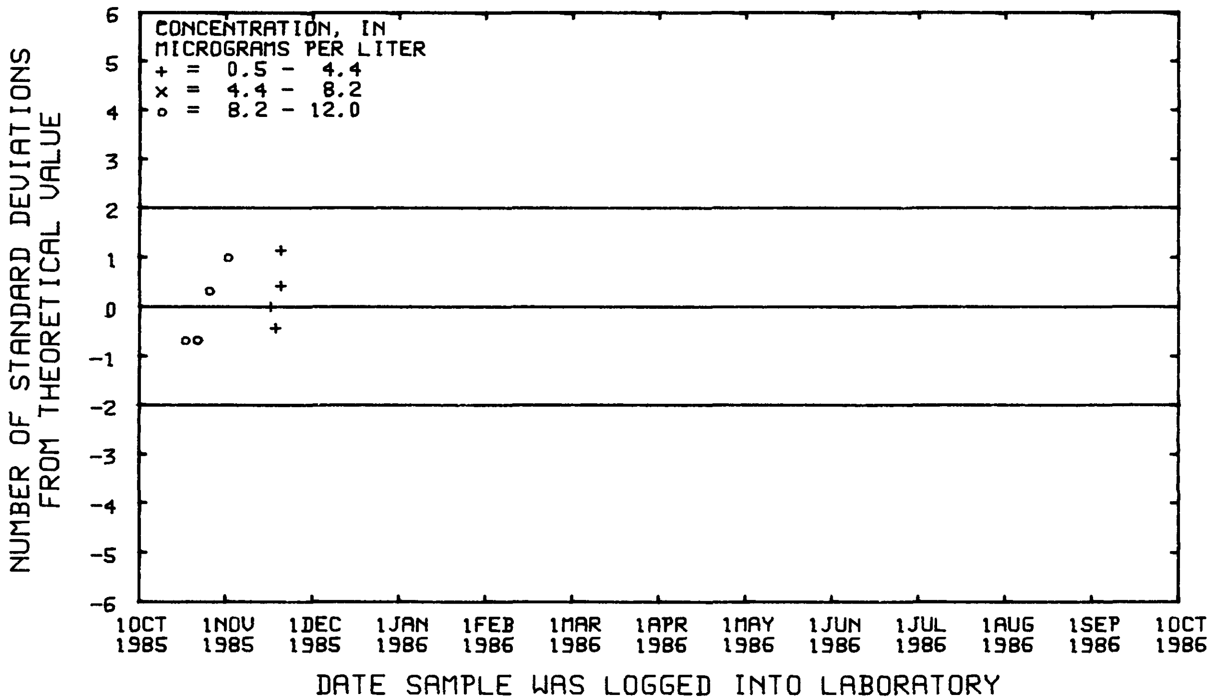


Figure 37.--Cobalt, dissolved,
(atomic absorption spectrometry)
data from the Atlanta laboratory.

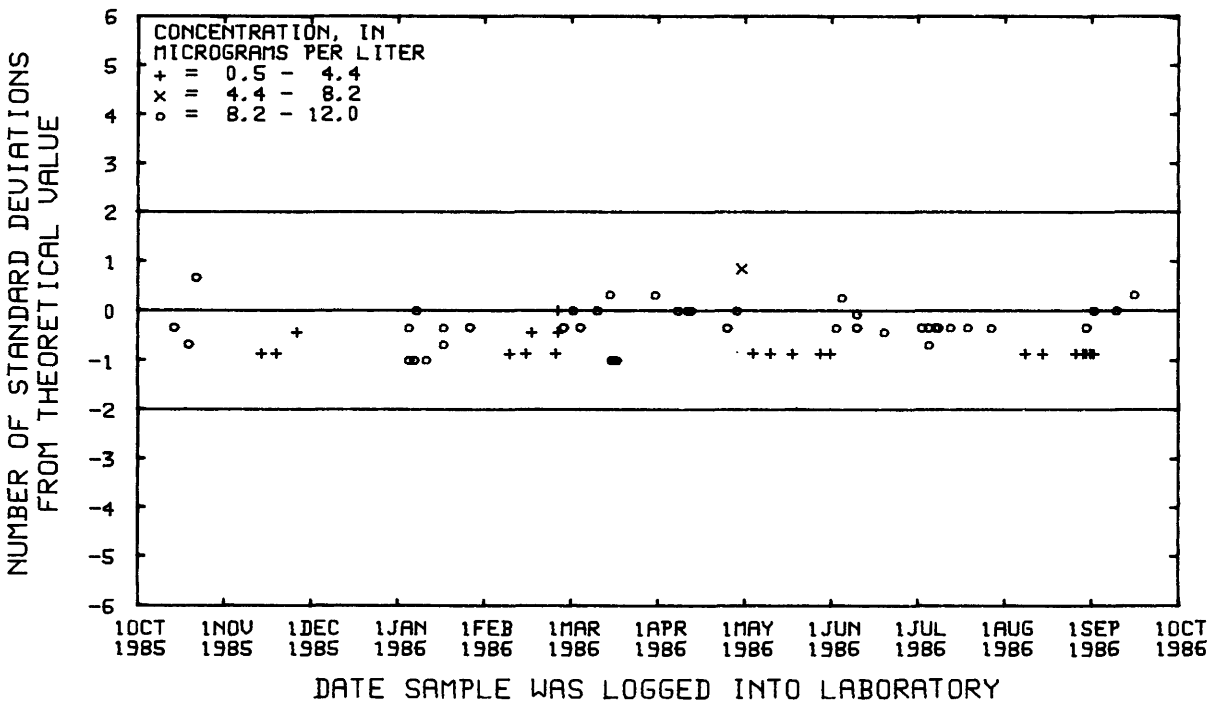


Figure 38.--Cobalt, dissolved,
(atomic absorption spectrometry)
data from the Denver laboratory.

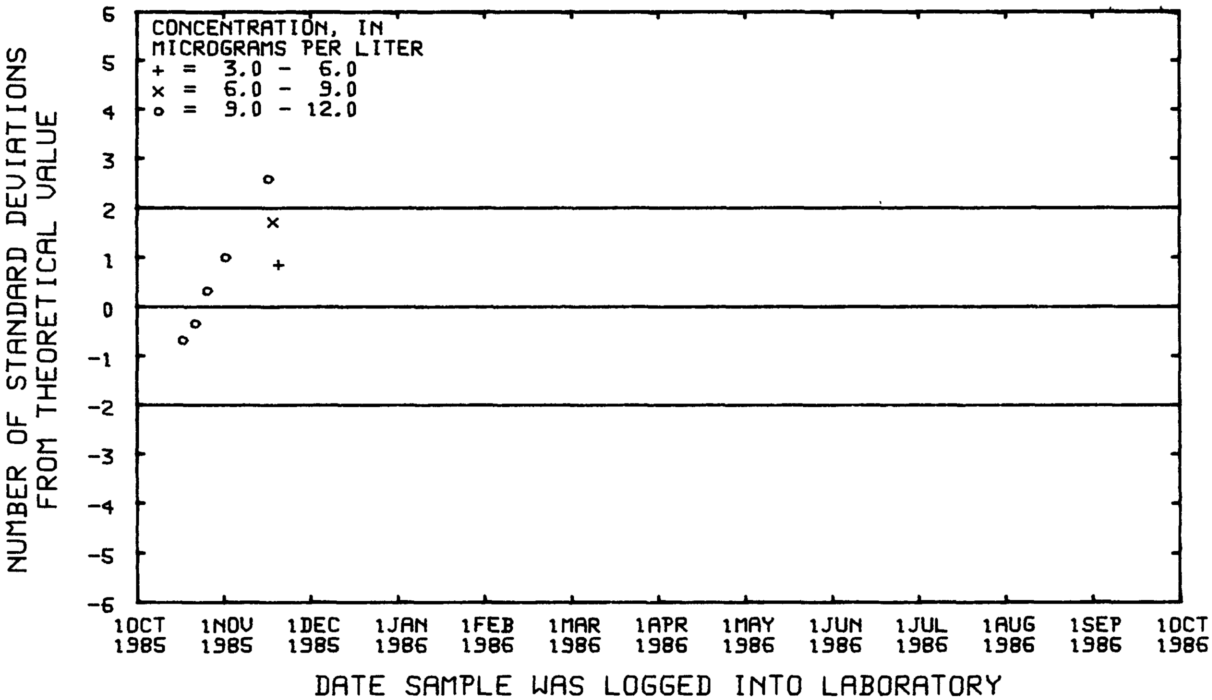


Figure 39.--Cobalt, total recoverable, data from the Atlanta laboratory.

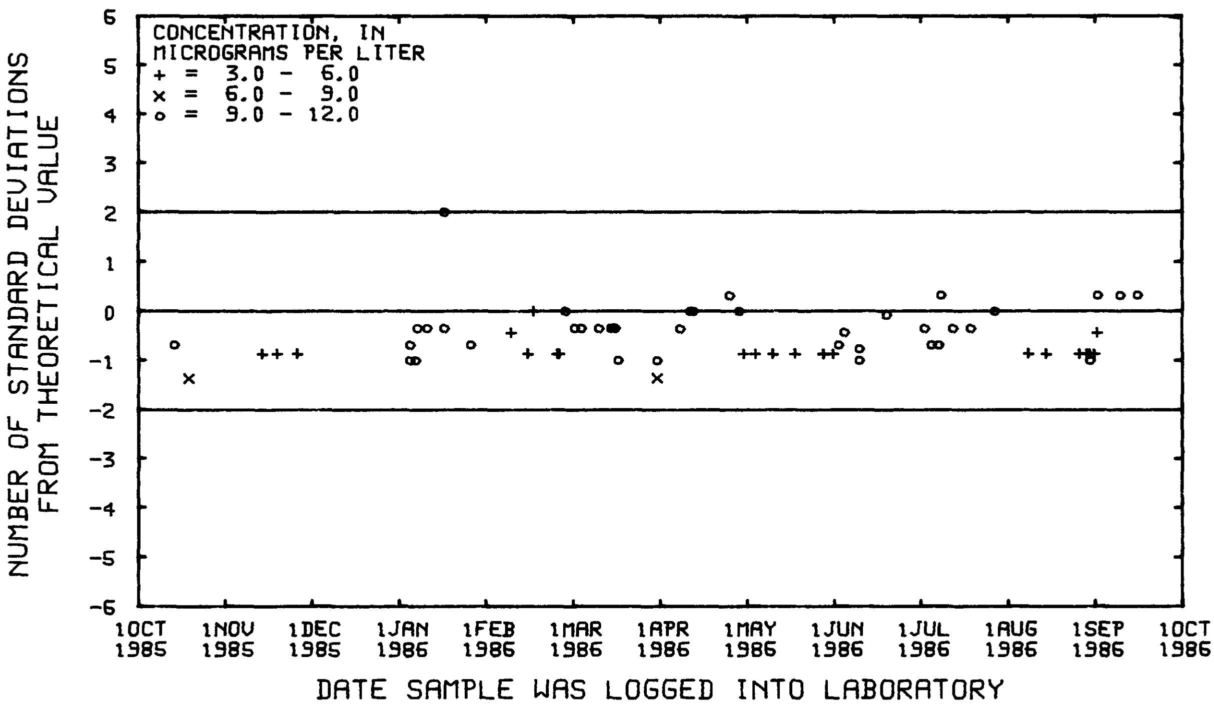


Figure 40.--Cobalt, total recoverable, data from the Denver laboratory.

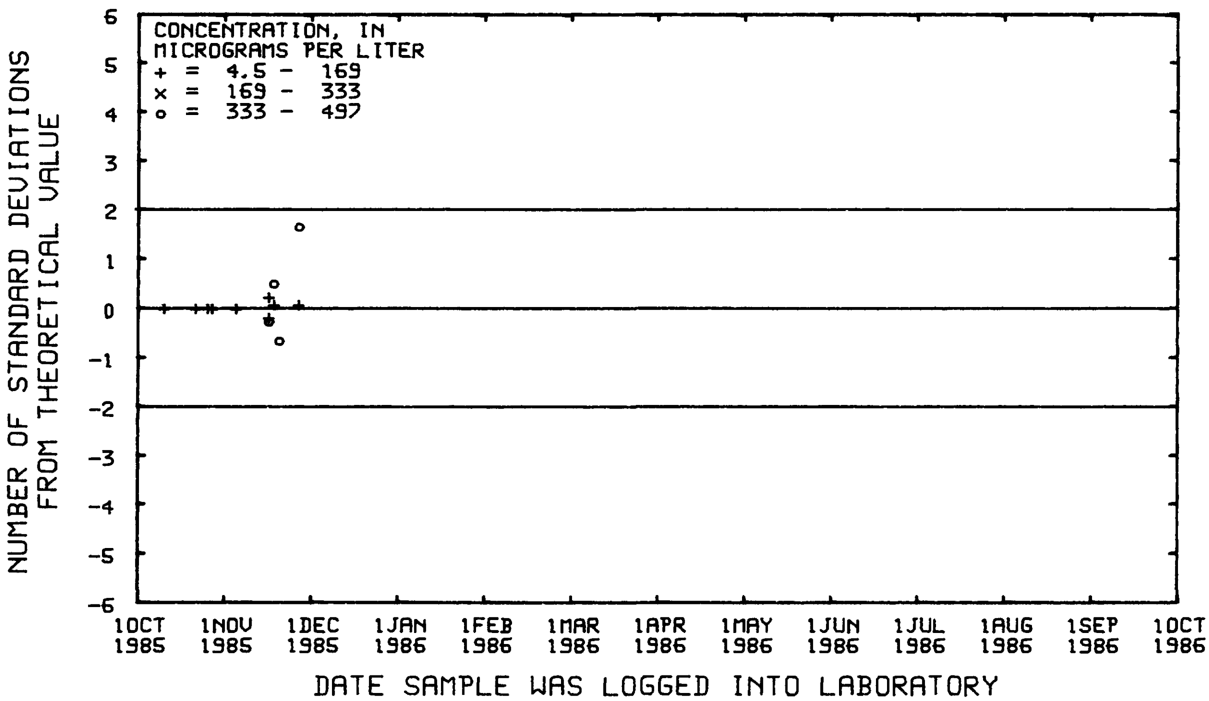


Figure 41.--Copper, dissolved, (inductively coupled plasma emission spectrometry) data from the Atlanta laboratory.

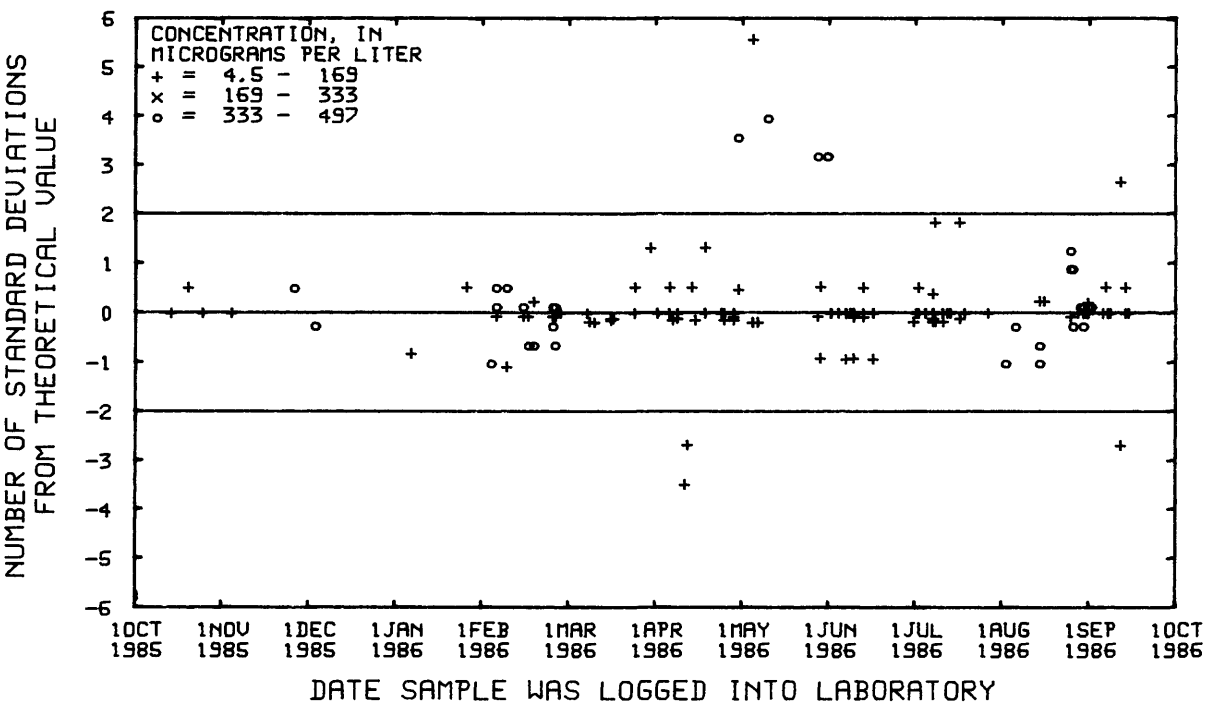


Figure 42.--Copper, dissolved, (inductively coupled plasma emission spectrometry) data from the Denver laboratory.

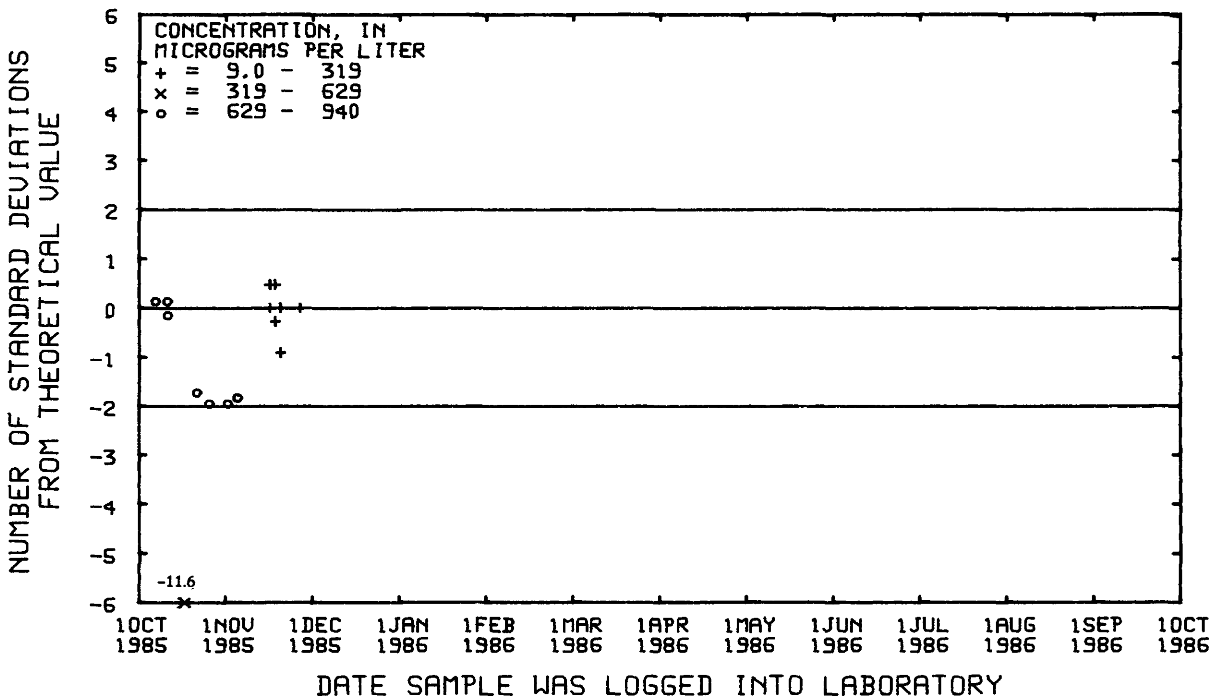


Figure 43.--Copper, dissolved, (atomic absorption spectrometry) data from the Atlanta laboratory.

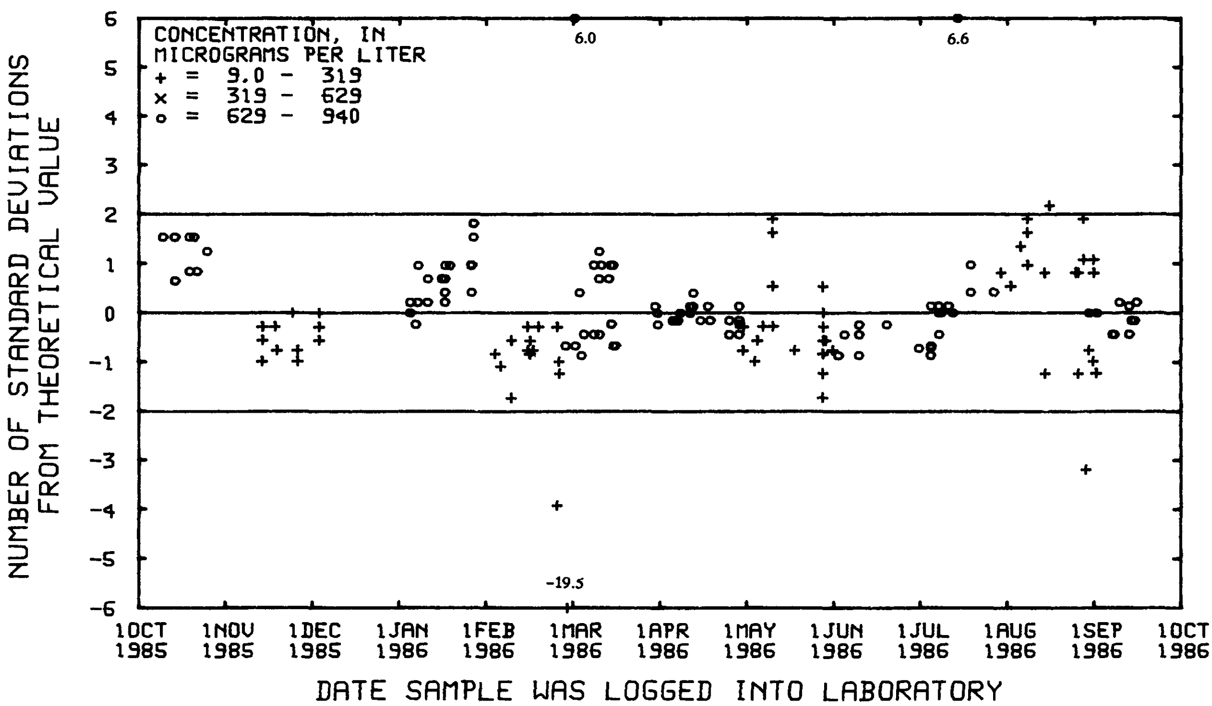


Figure 44.--Copper, dissolved, (atomic absorption spectrometry) data from the Denver laboratory.

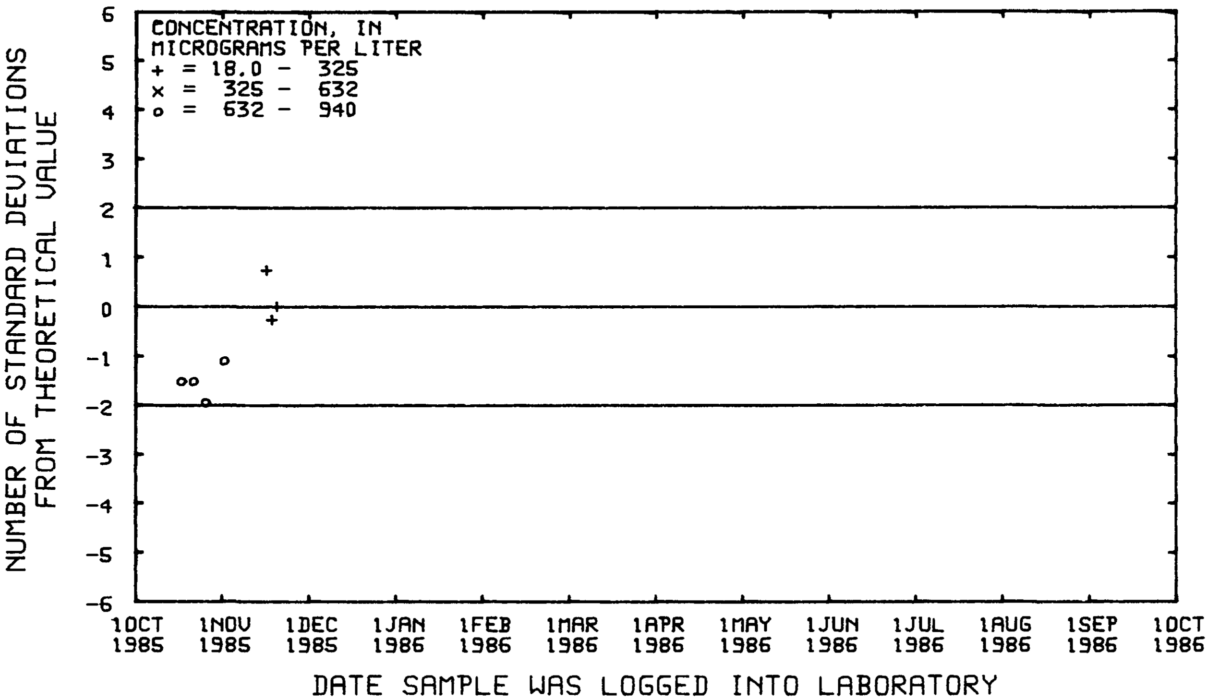


Figure 45.--Copper, total recoverable, data from the Atlanta laboratory.

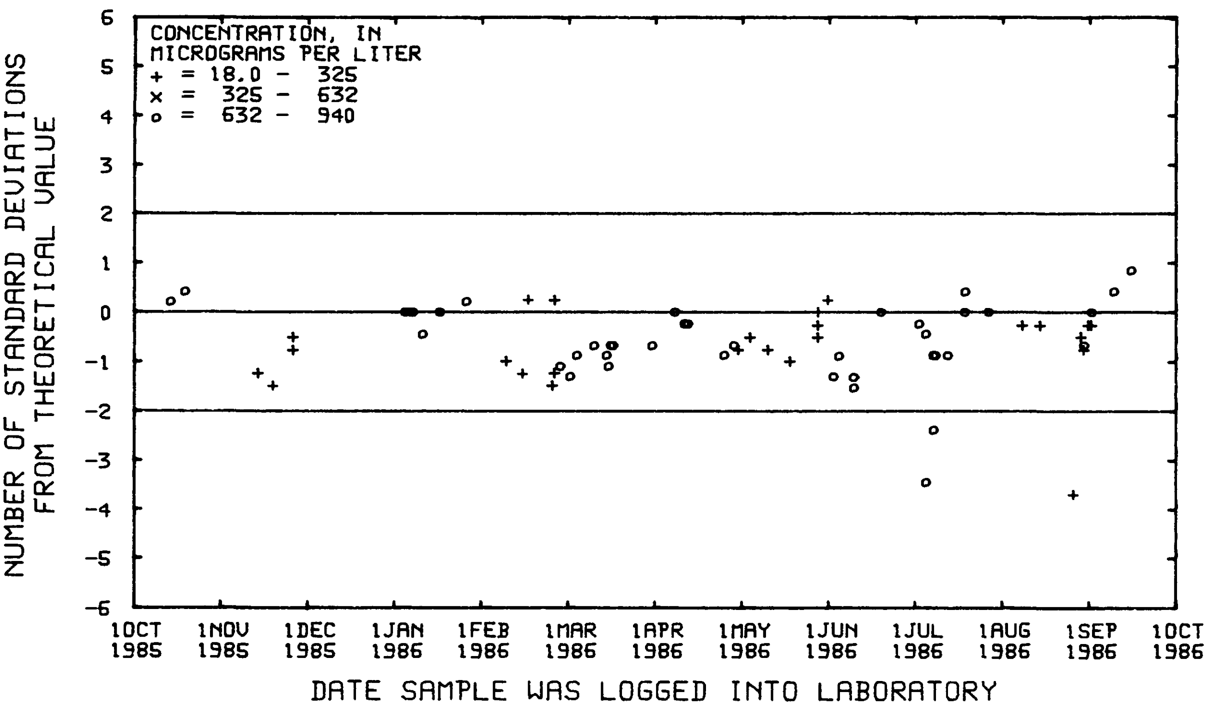


Figure 46.--Copper, total recoverable, data from the Denver laboratory.

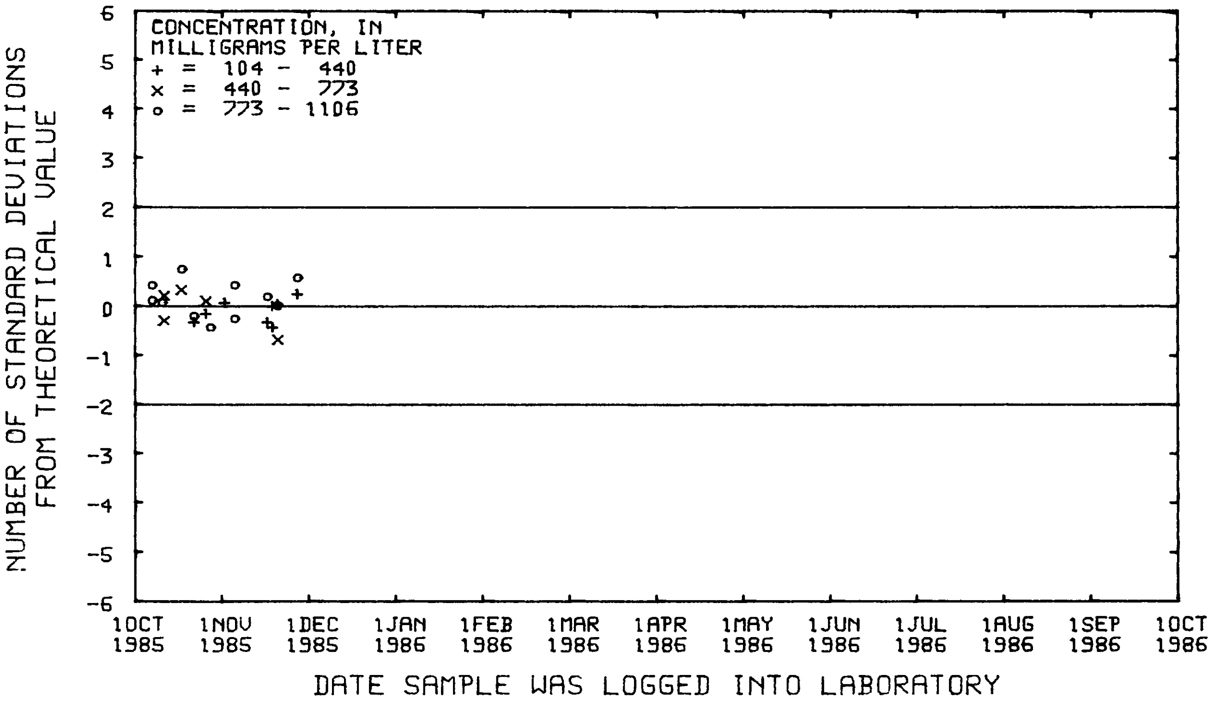


Figure 47.--Dissolved solids data from the Atlanta laboratory.

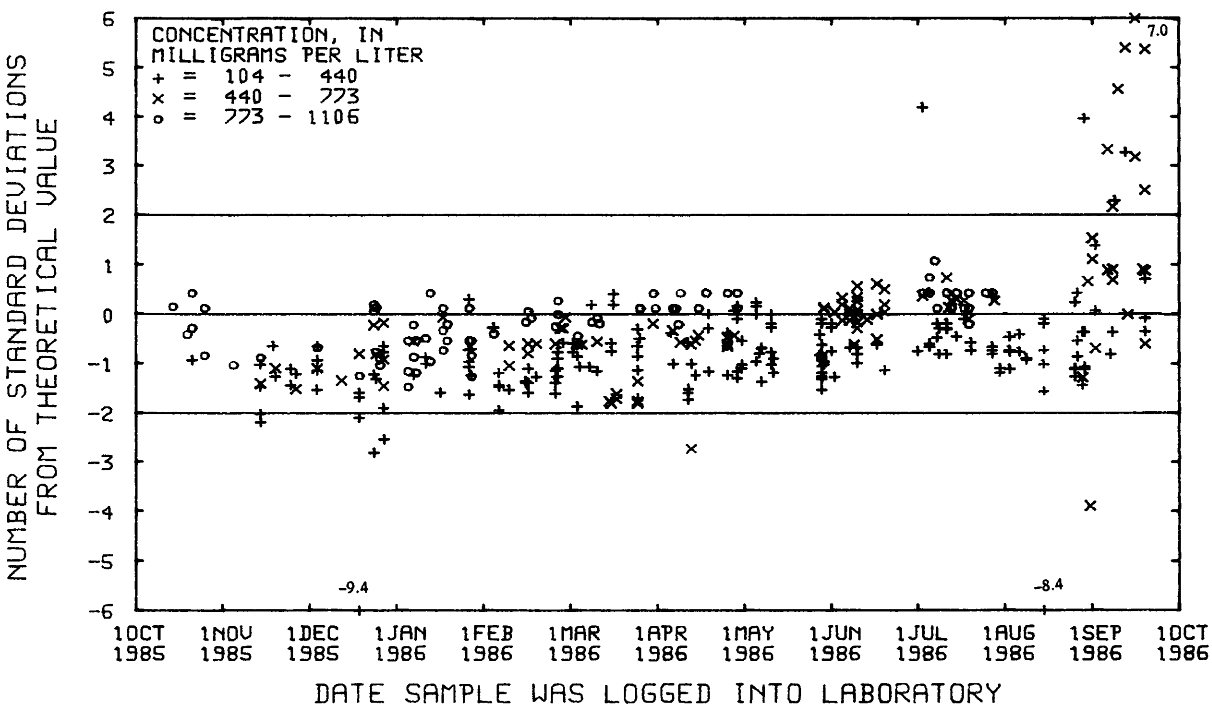


Figure 48.--Dissolved solids data from the Denver laboratory.

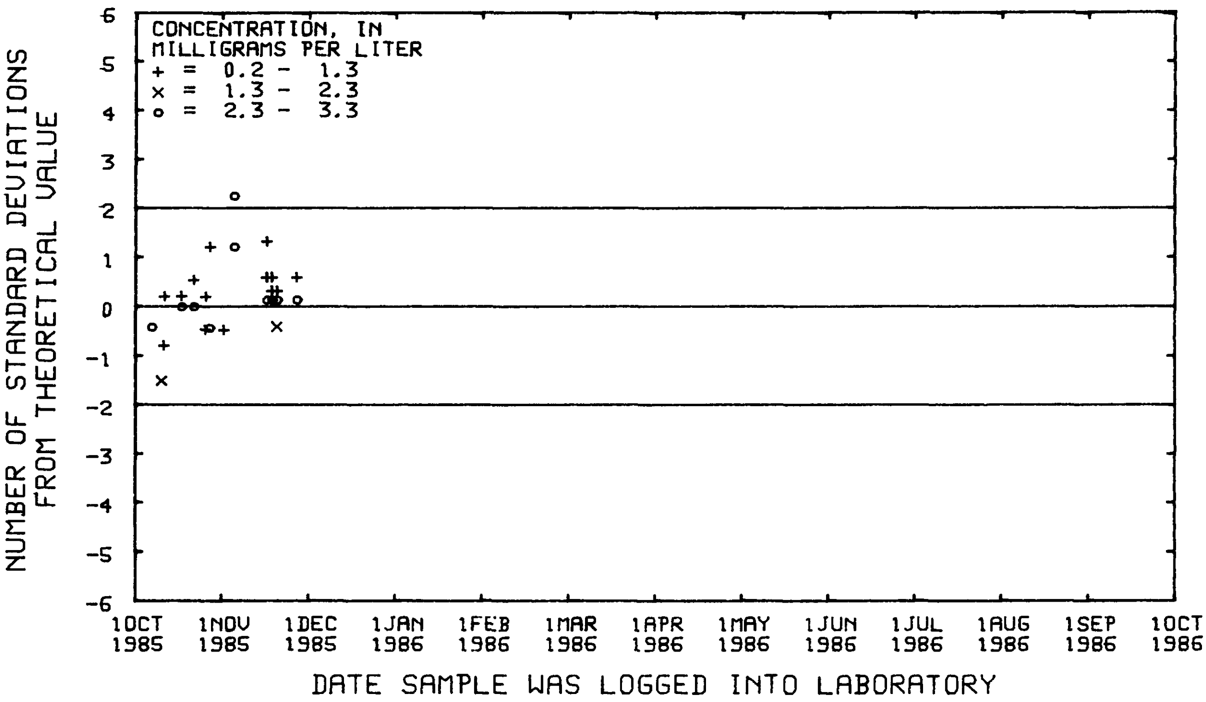


Figure 49.--Fluoride, dissolved, data from the Atlanta laboratory.

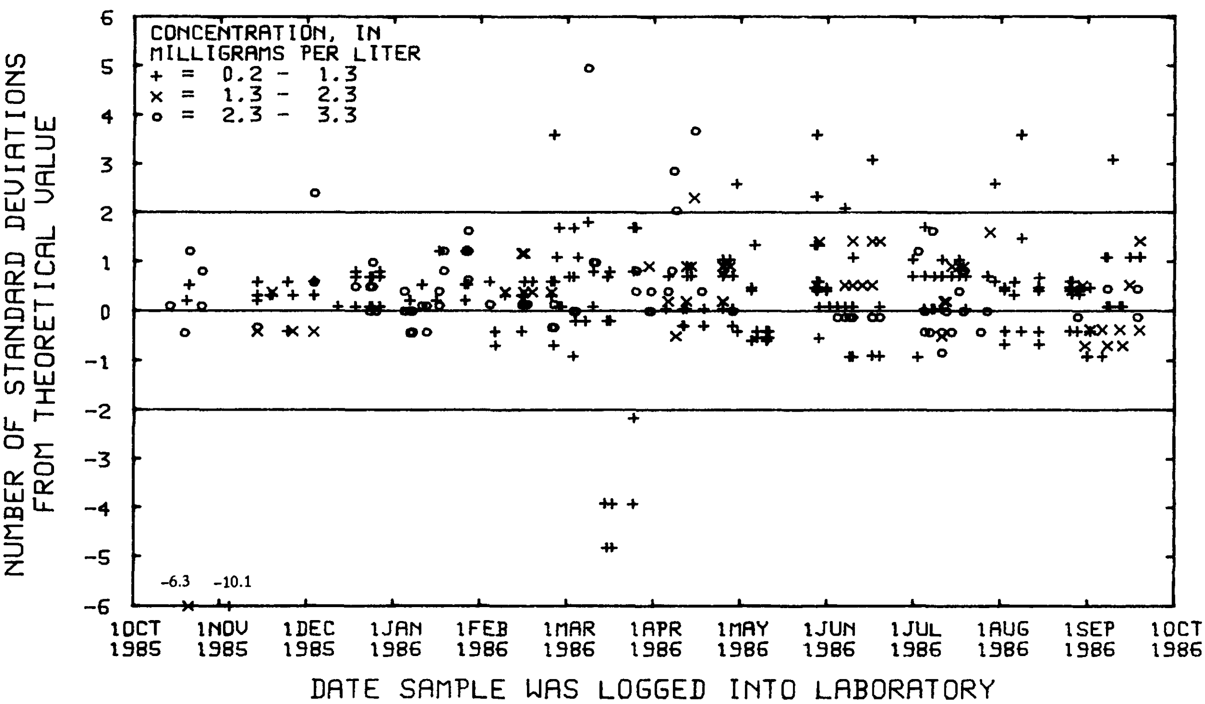


Figure 50.--Fluoride, dissolved, data from the Denver laboratory.

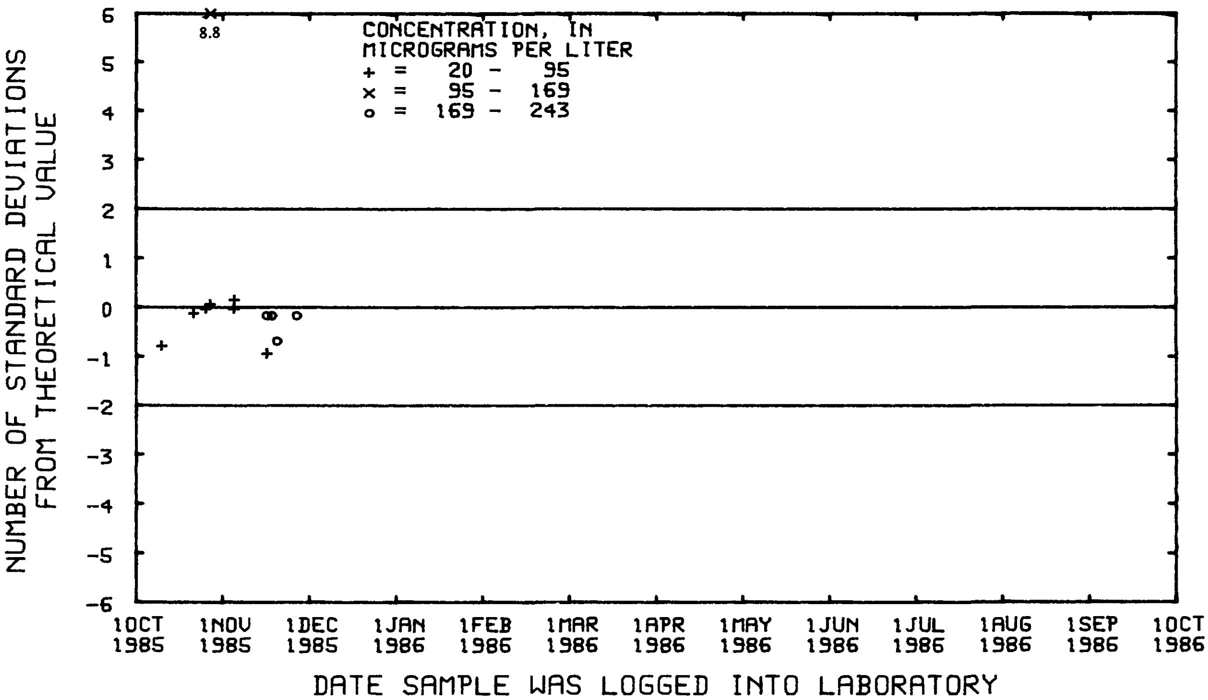


Figure 51.--Iron, dissolved,
(inductively coupled plasma emission spectrometry)
data from the Atlanta laboratory.

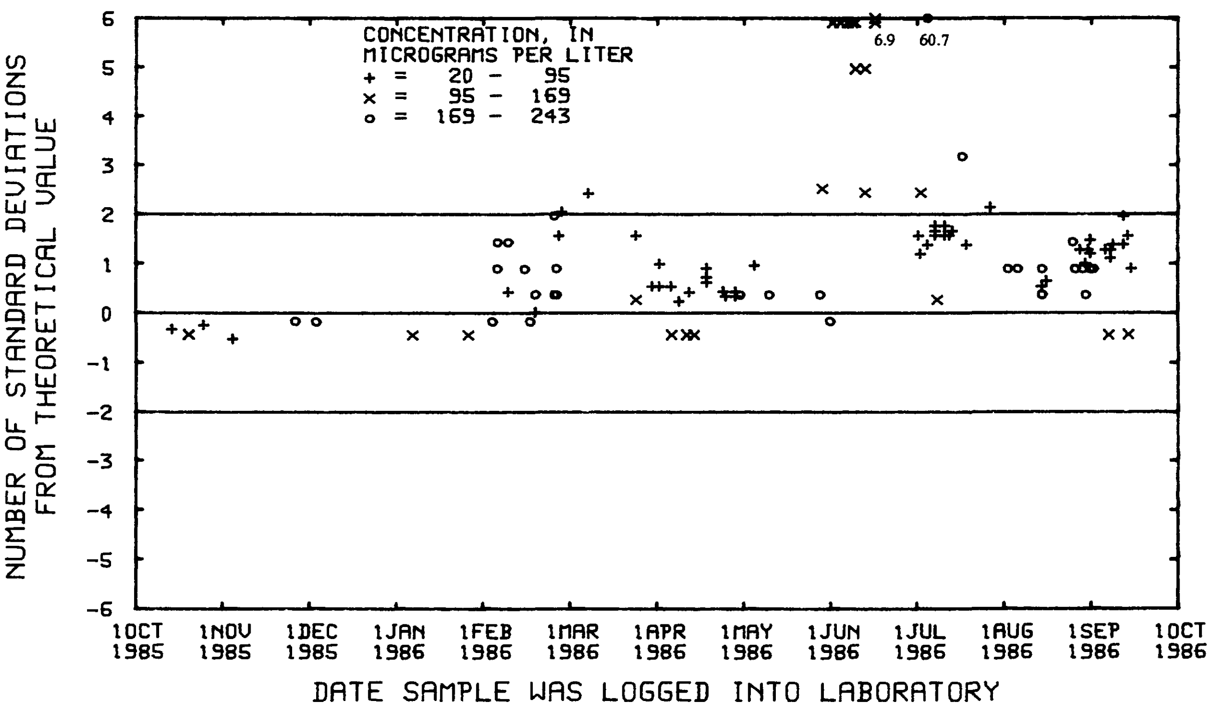


Figure 52.--Iron, dissolved,
(inductively coupled plasma emission spectrometry)
data from the Denver laboratory.

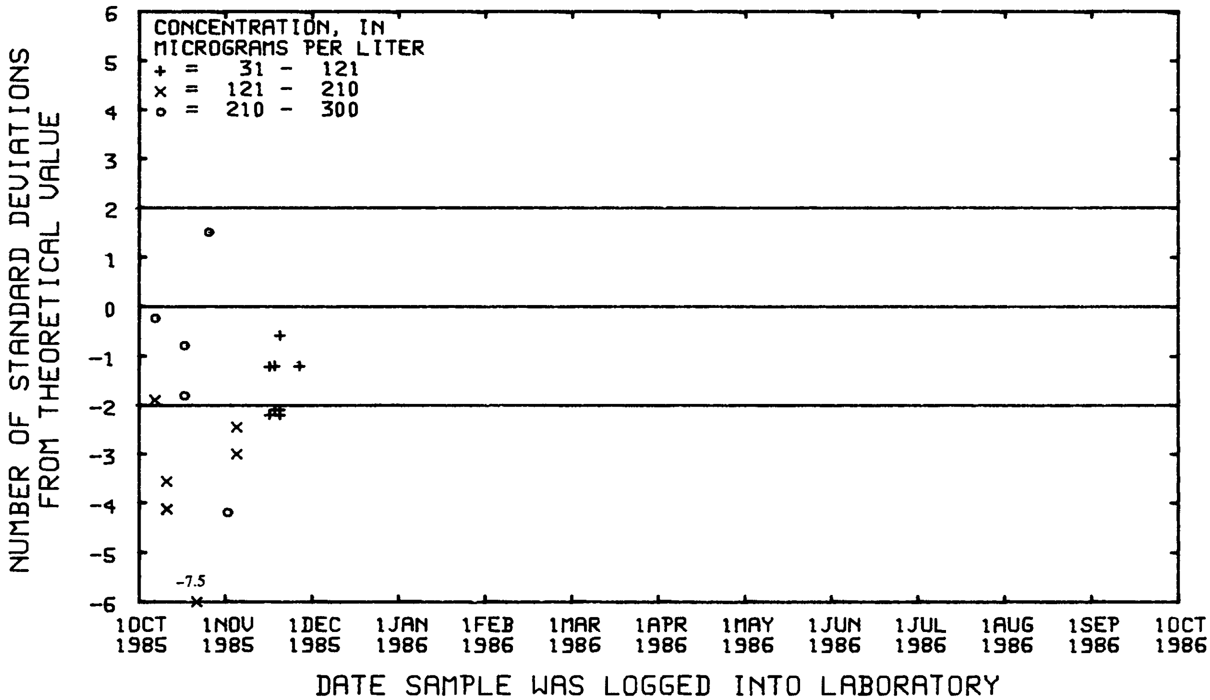


Figure 53.--Iron, dissolved, (atomic absorption spectrometry) data from the Atlanta laboratory.

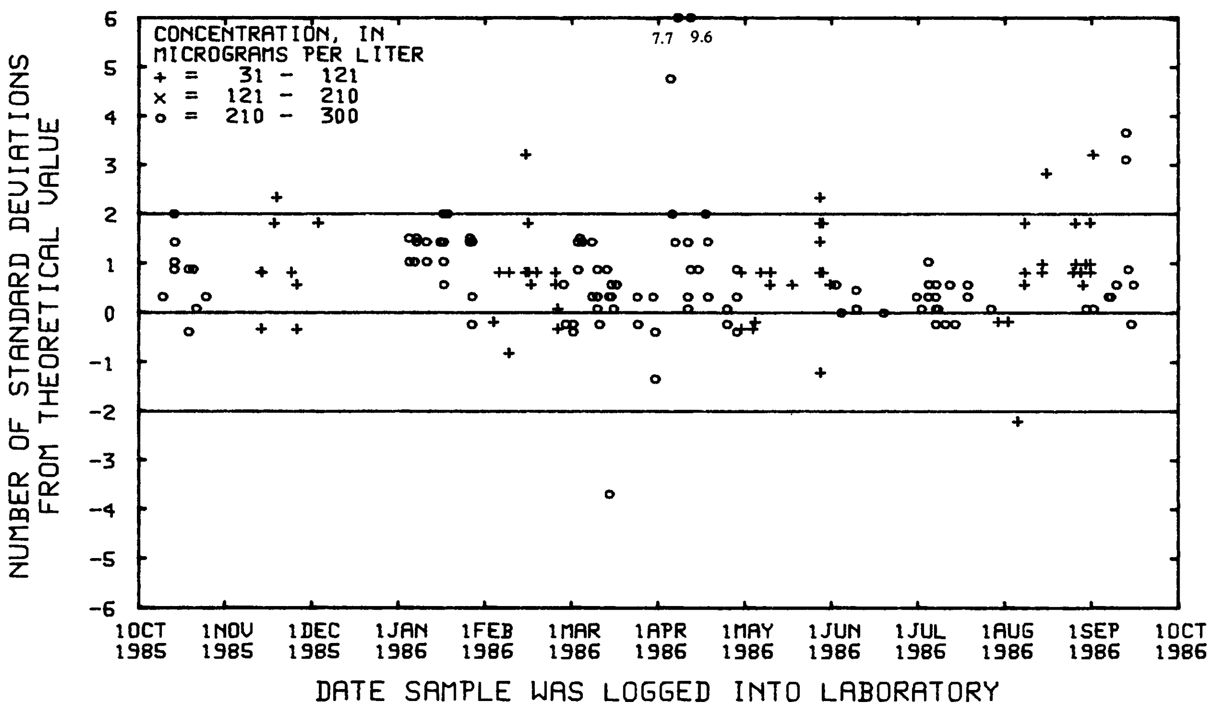


Figure 54.--Iron, dissolved, (atomic absorption spectrometry) data from the Denver laboratory.

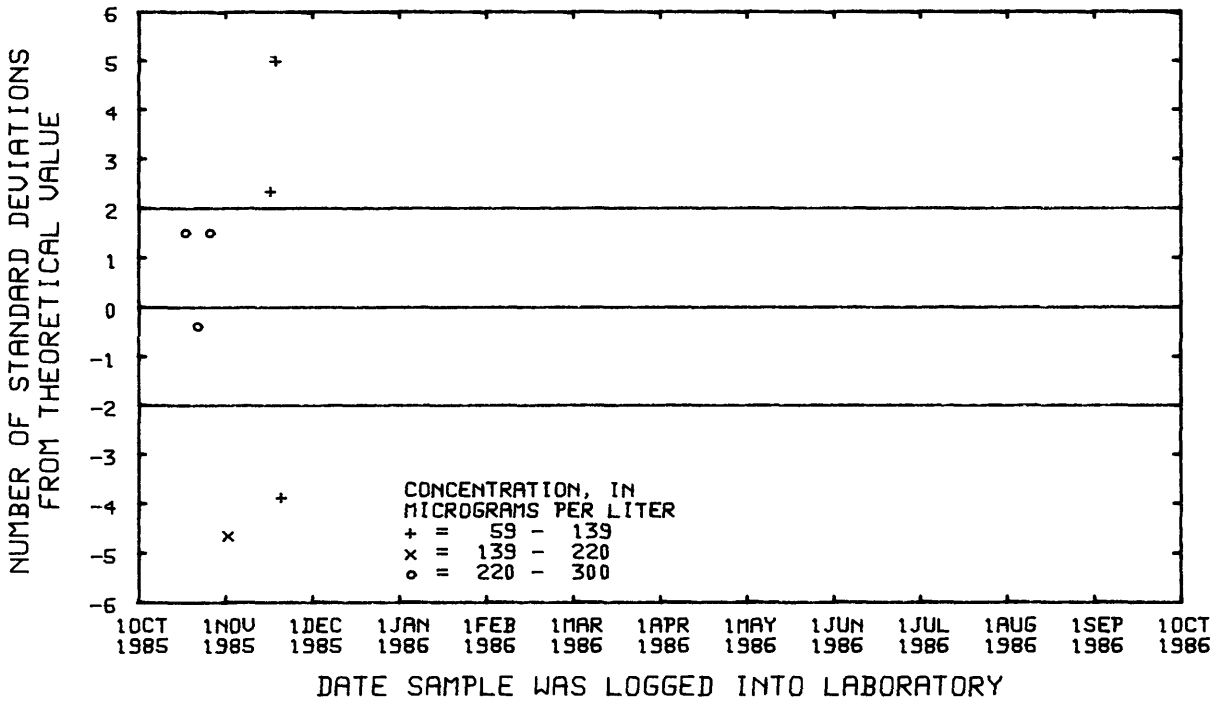


Figure 55.--Iron, total recoverable, data from the Atlanta laboratory.

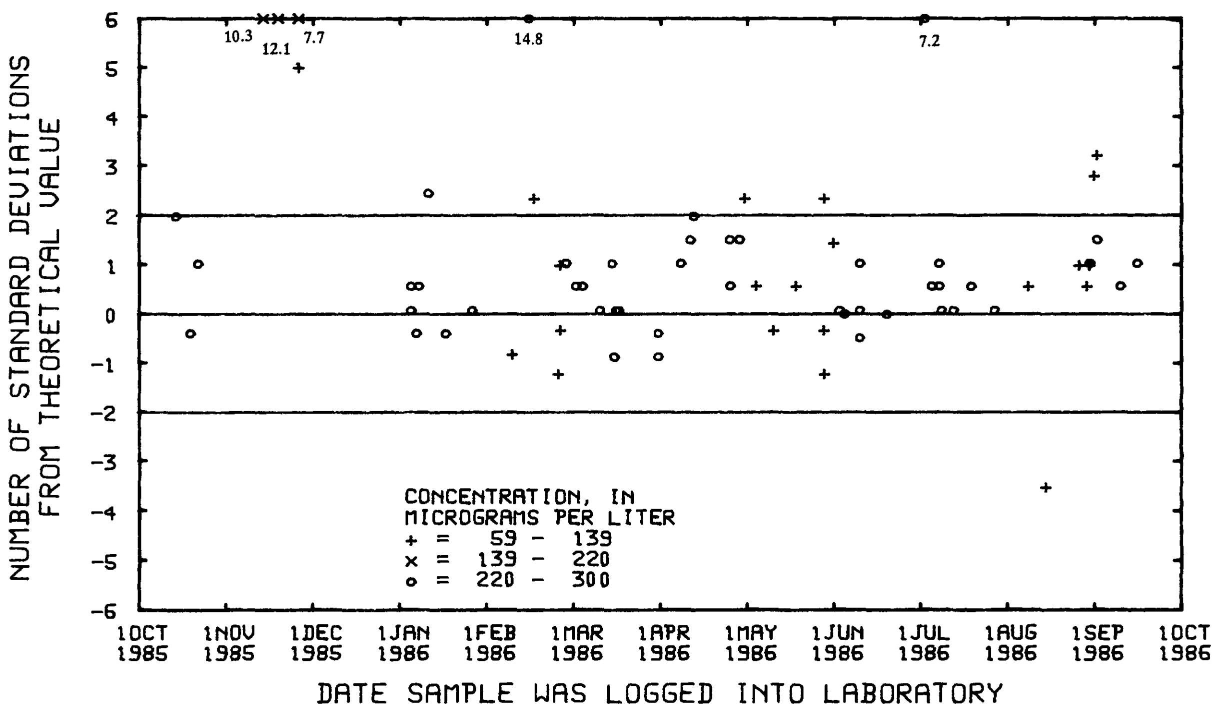


Figure 56.--Iron, total recoverable, data from the Denver laboratory.

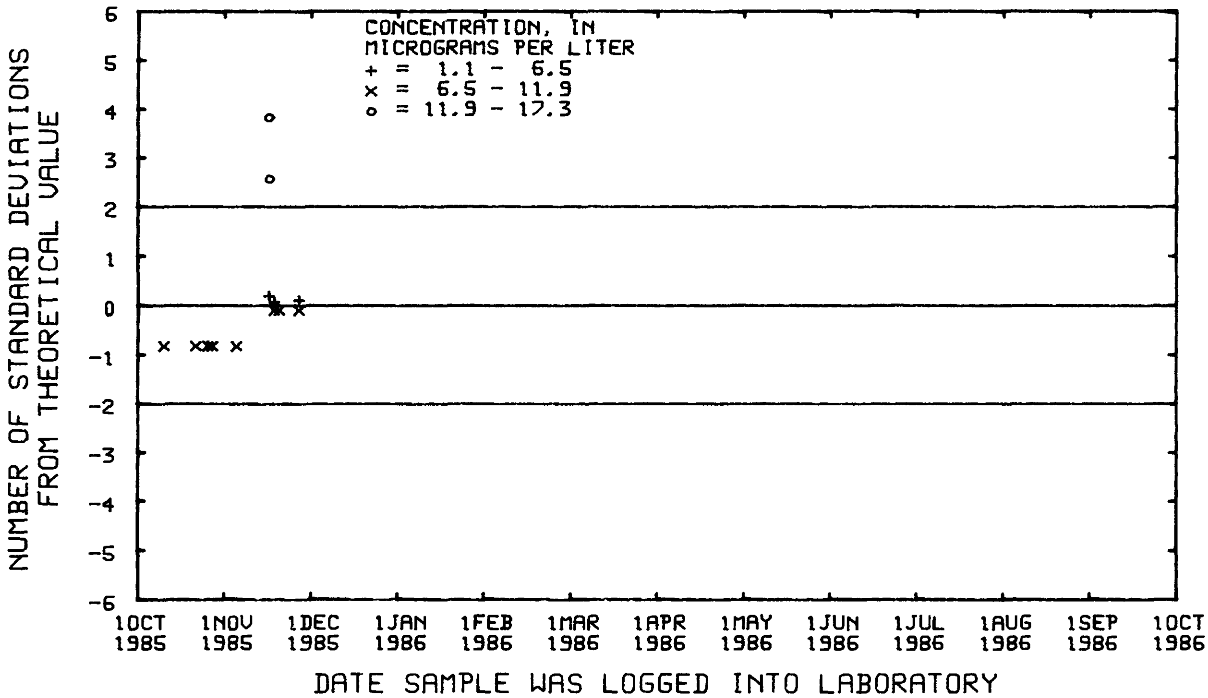


Figure 57.--Lead, dissolved,
(inductively coupled plasma emission spectrometry)
data from the Atlanta laboratory.

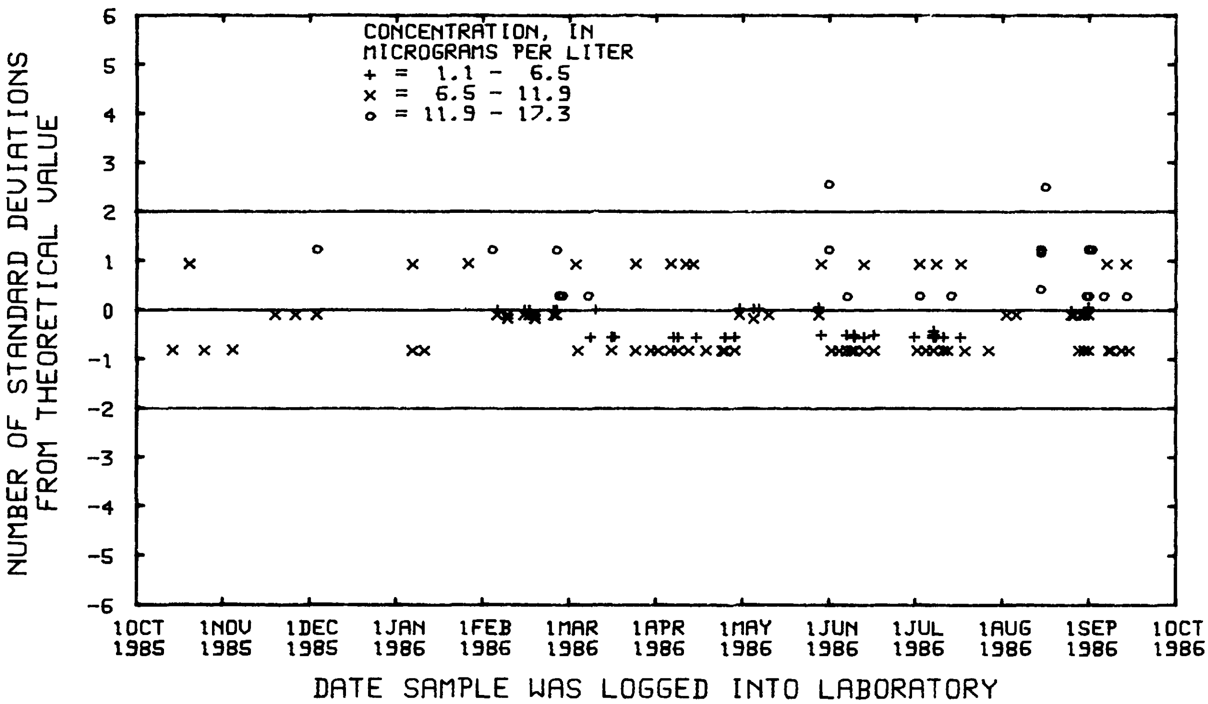


Figure 58.--Lead, dissolved,
(inductively coupled plasma emission spectrometry)
data from the Denver laboratory.

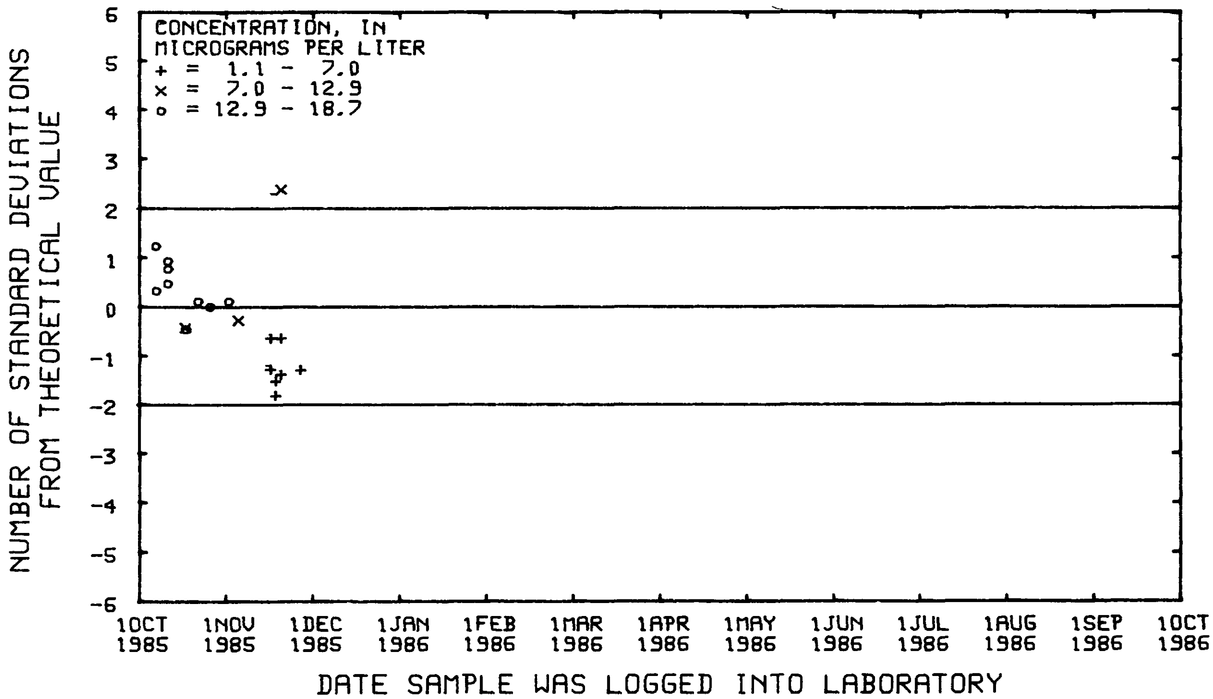


Figure 59.--Lead, dissolved, (atomic absorption spectrometry) data from the Atlanta laboratory.

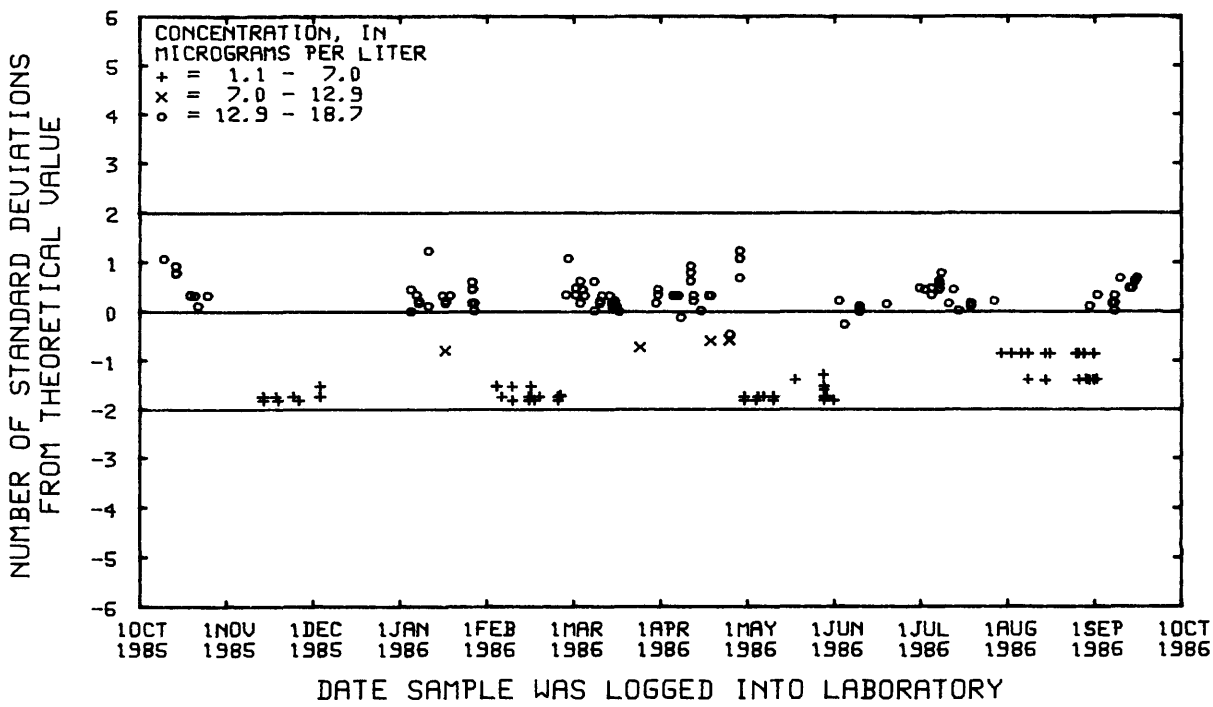


Figure 60.--Lead, dissolved, (atomic absorption spectrometry) data from the Denver laboratory.

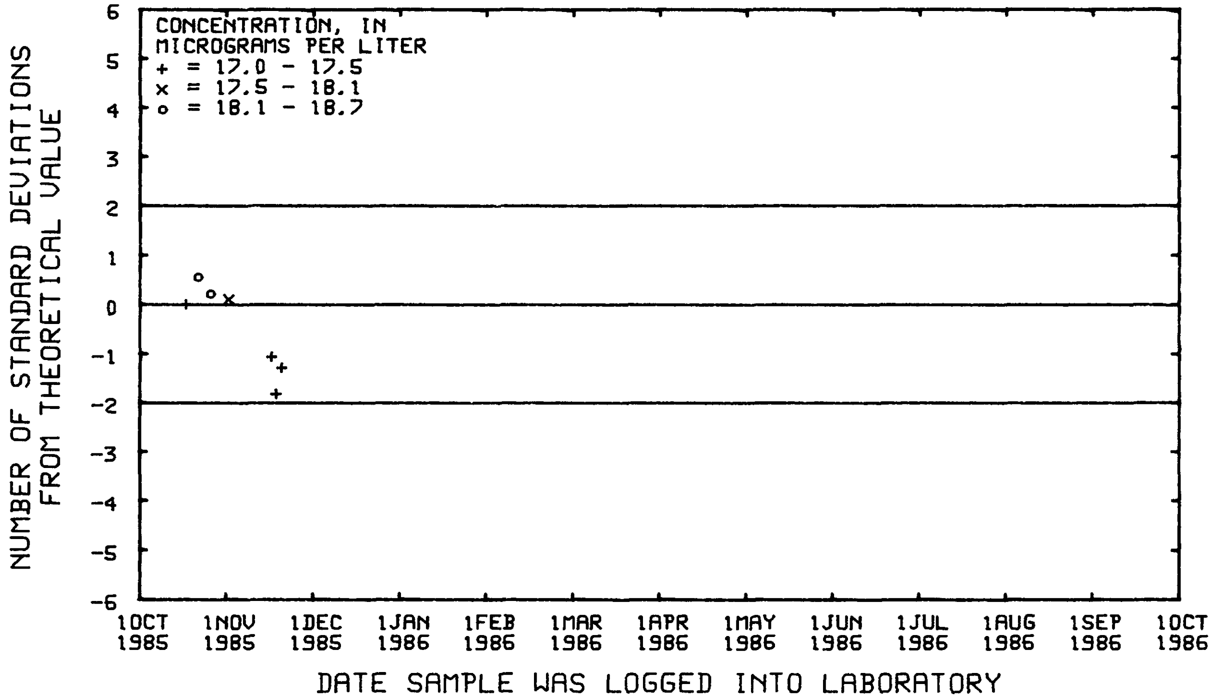


Figure 61.--Lead, total recoverable, data from the Atlanta laboratory.

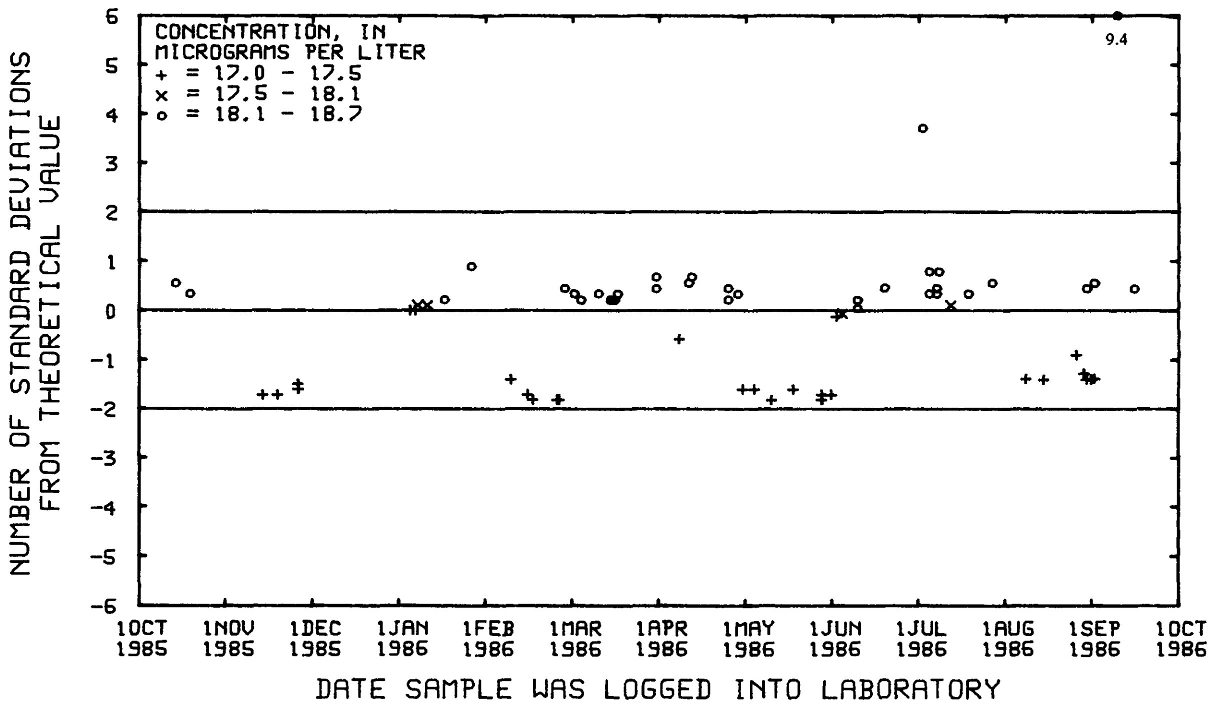


Figure 62.--Lead, total recoverable, data from the Denver laboratory.

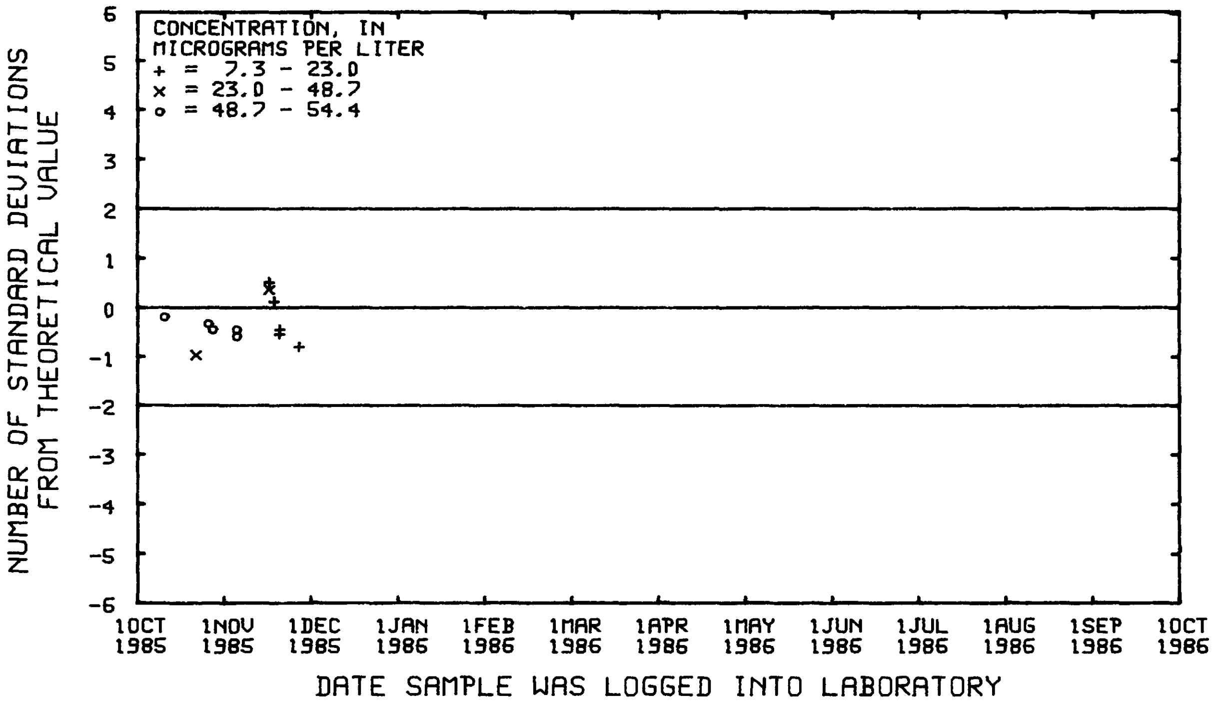


Figure 63.--Lithium, dissolved, data from the Atlanta laboratory.

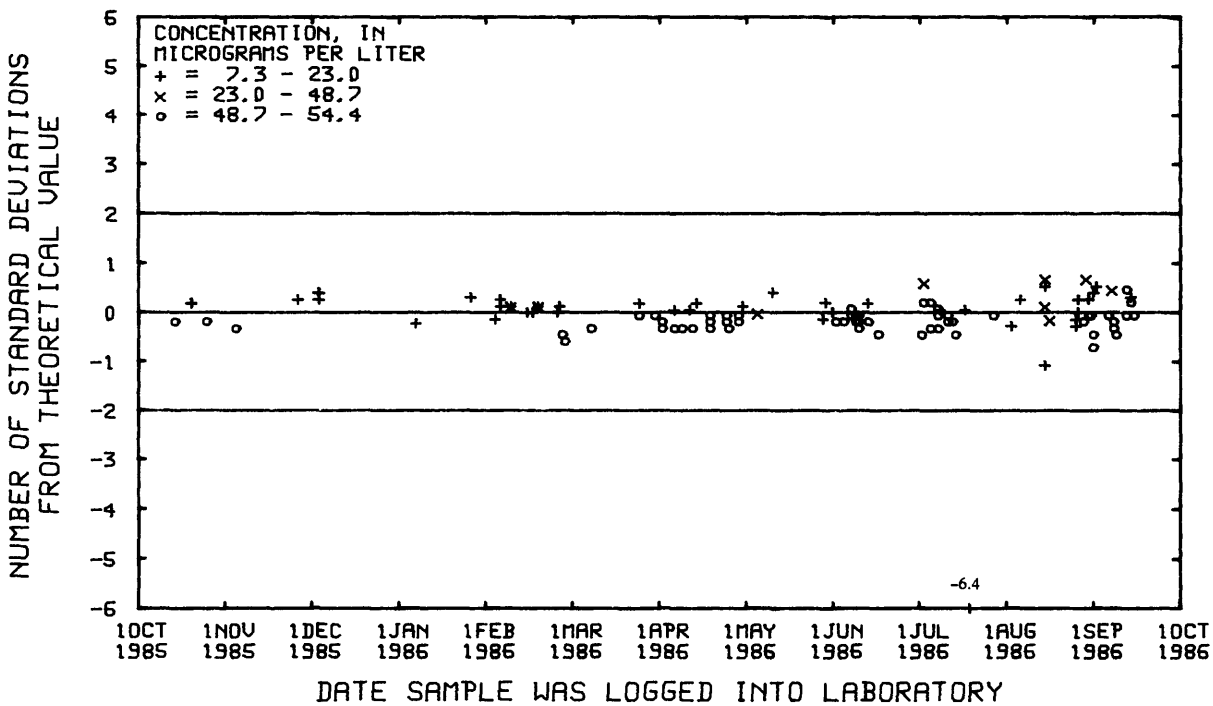


Figure 64.--Lithium, dissolved, data from the Denver laboratory.

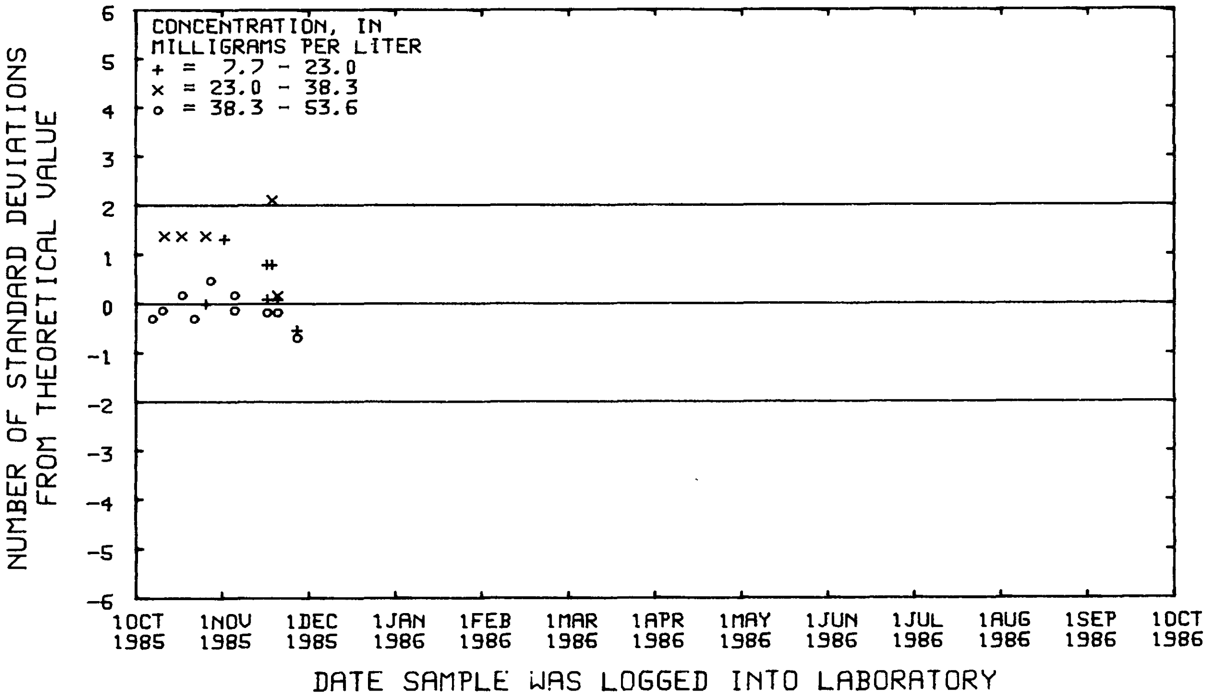


Figure 65.--Magnesium, dissolved, (inductively coupled plasma emission spectrometry) data from the Atlanta laboratory.

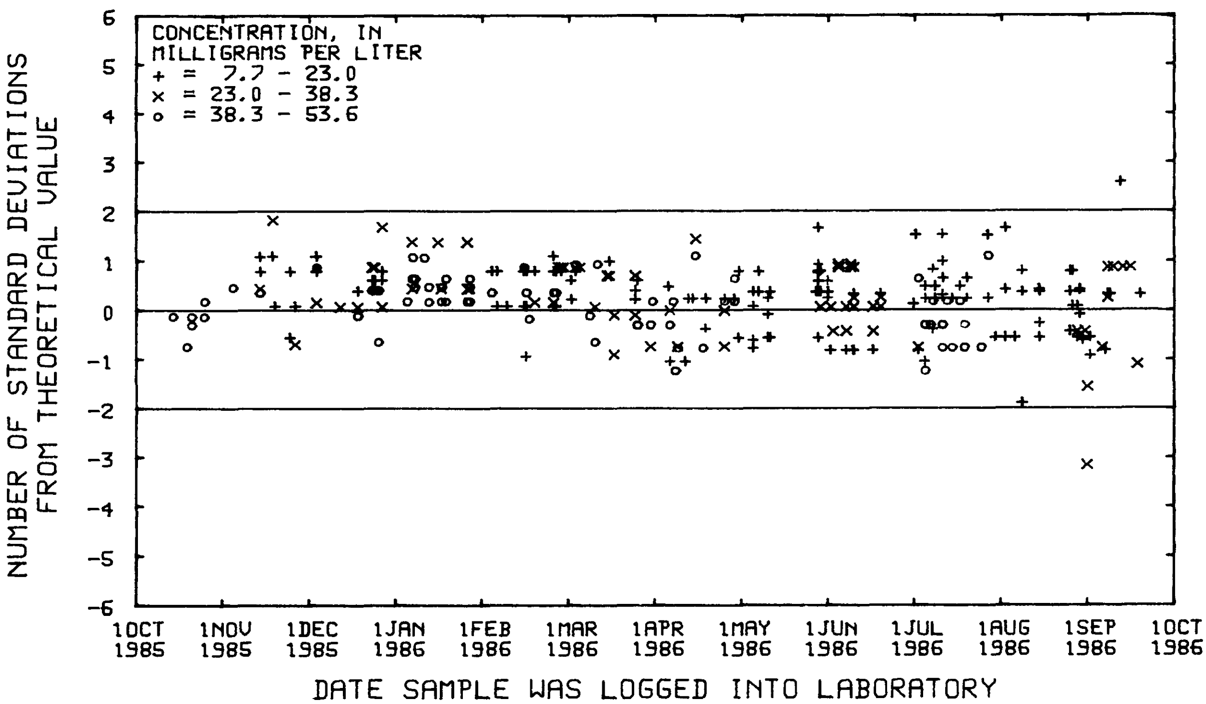


Figure 66.--Magnesium, dissolved, (inductively coupled plasma emission spectrometry) data from the Denver laboratory.

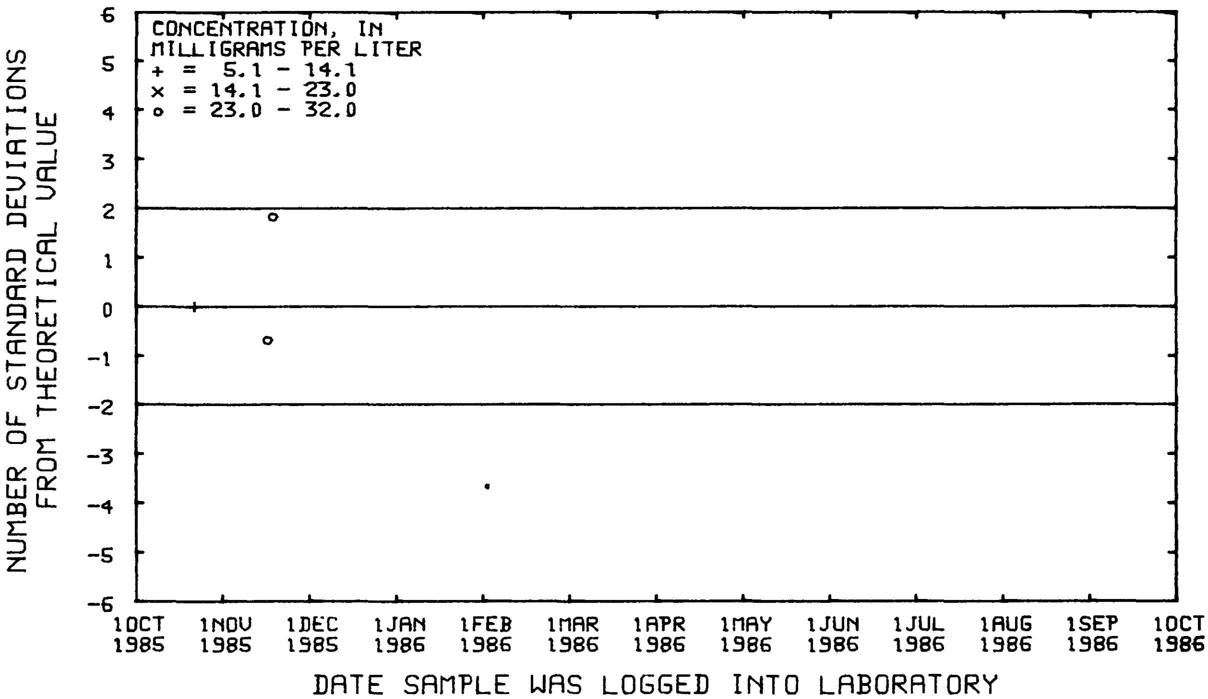


Figure 67.--Magnesium, dissolved, (atomic absorption spectrometry) data from the Atlanta laboratory.

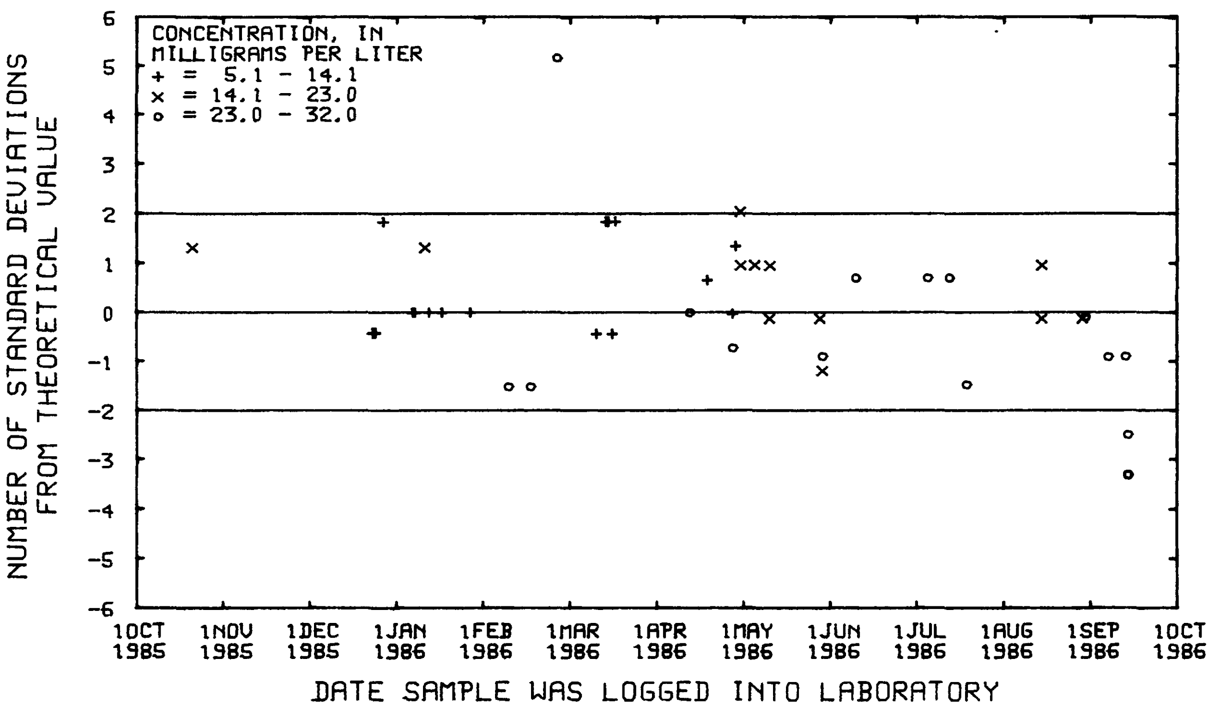


Figure 68.--Magnesium, dissolved, (atomic absorption spectrometry) data from the Denver laboratory.

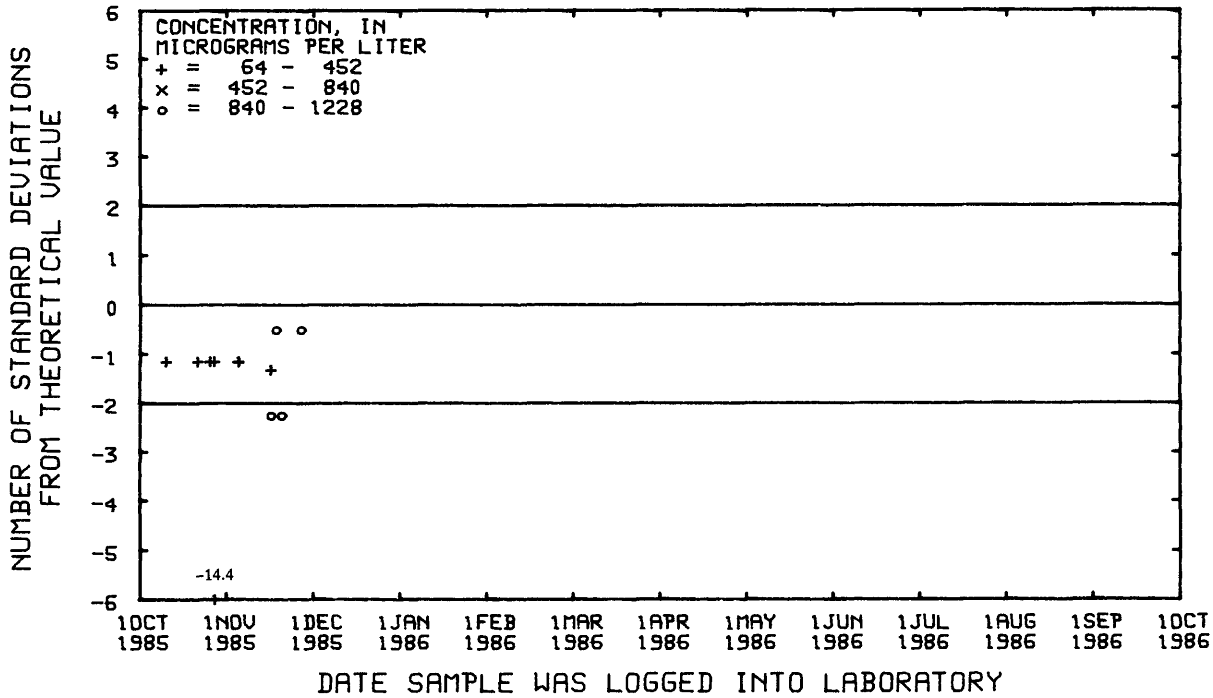


Figure 69.--Manganese, dissolved, (inductively coupled plasma emission spectrometry) data from the Atlanta laboratory.

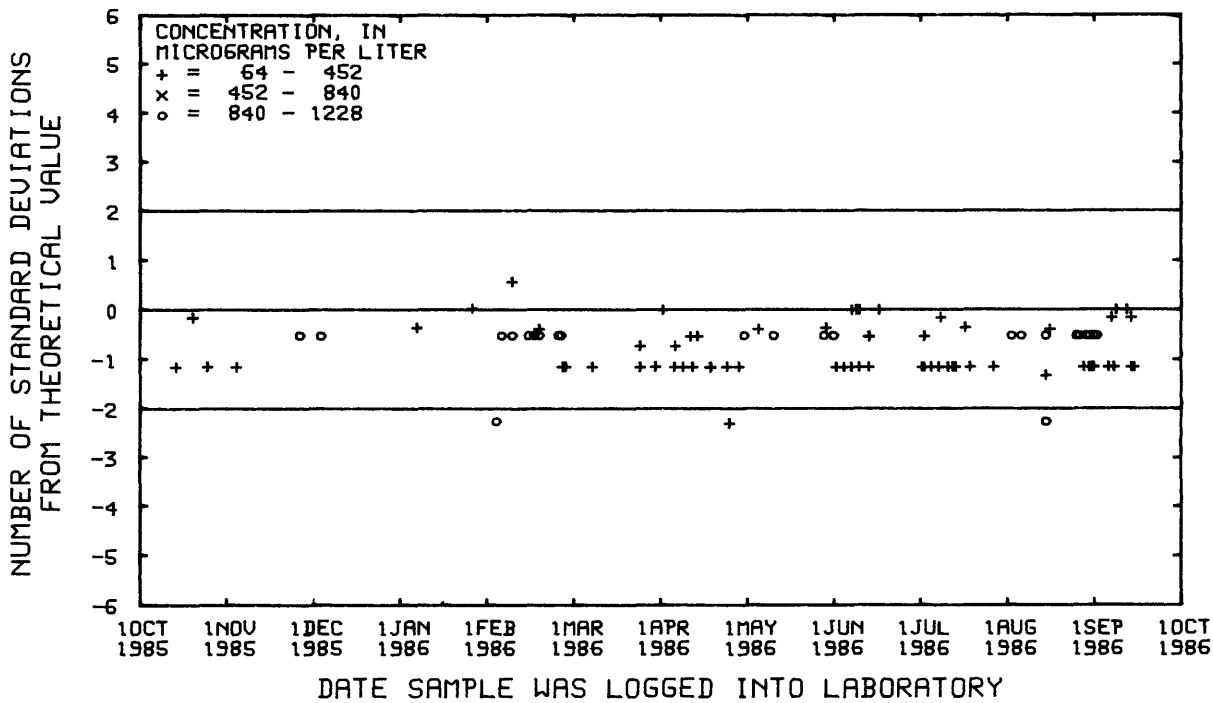


Figure 70.--Manganese, dissolved, (inductively coupled plasma emission spectrometry) data from the Denver laboratory.

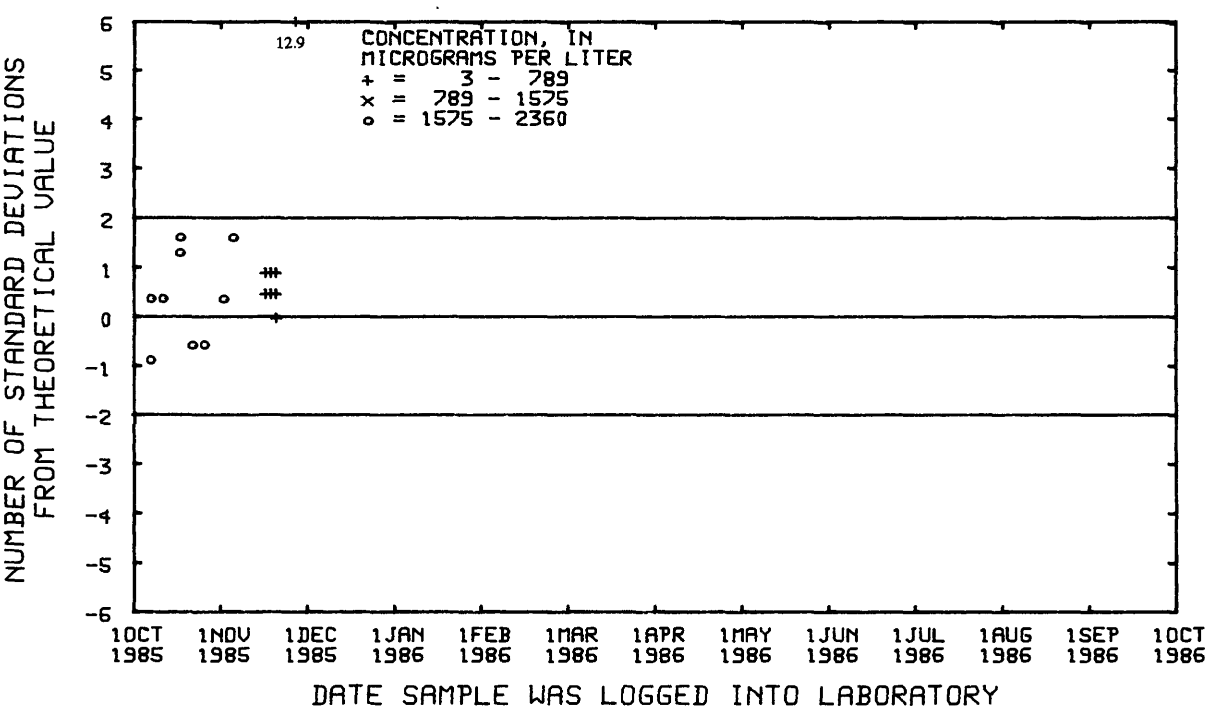


Figure 71.--Manganese, dissolved, (atomic absorption spectrometry) data from the Atlanta laboratory.

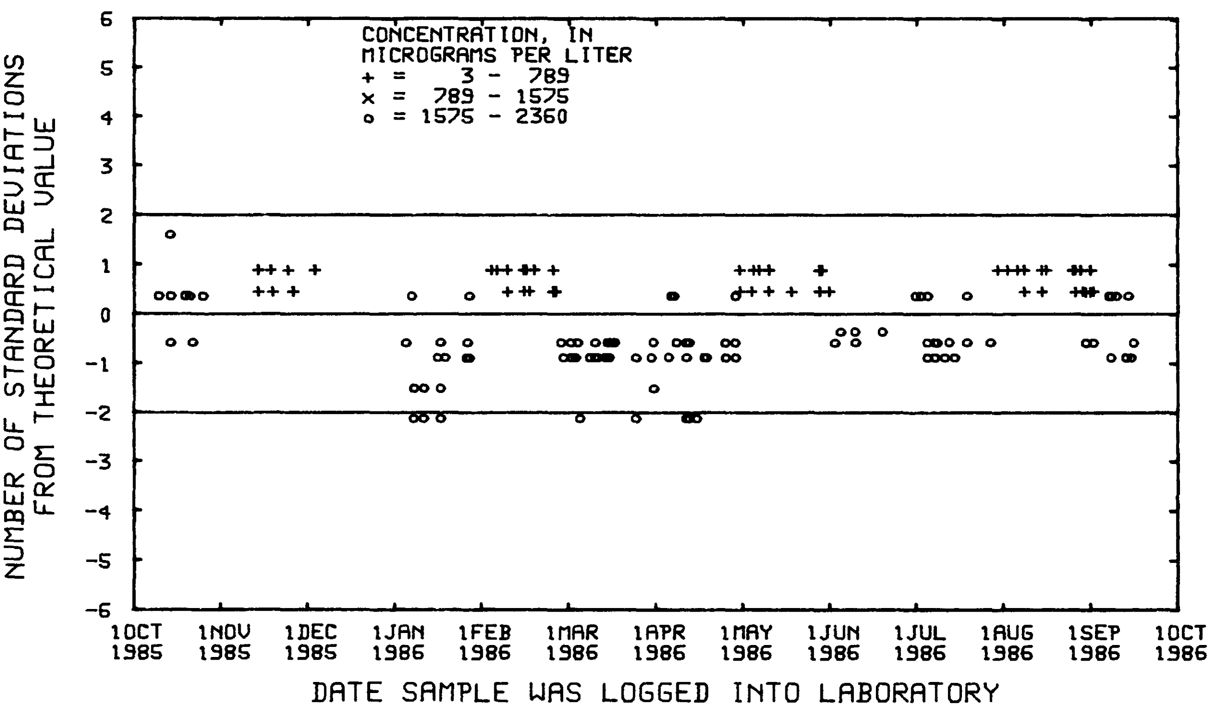


Figure 72.--Manganese, dissolved, (atomic absorption spectrometry) data from the Denver laboratory.

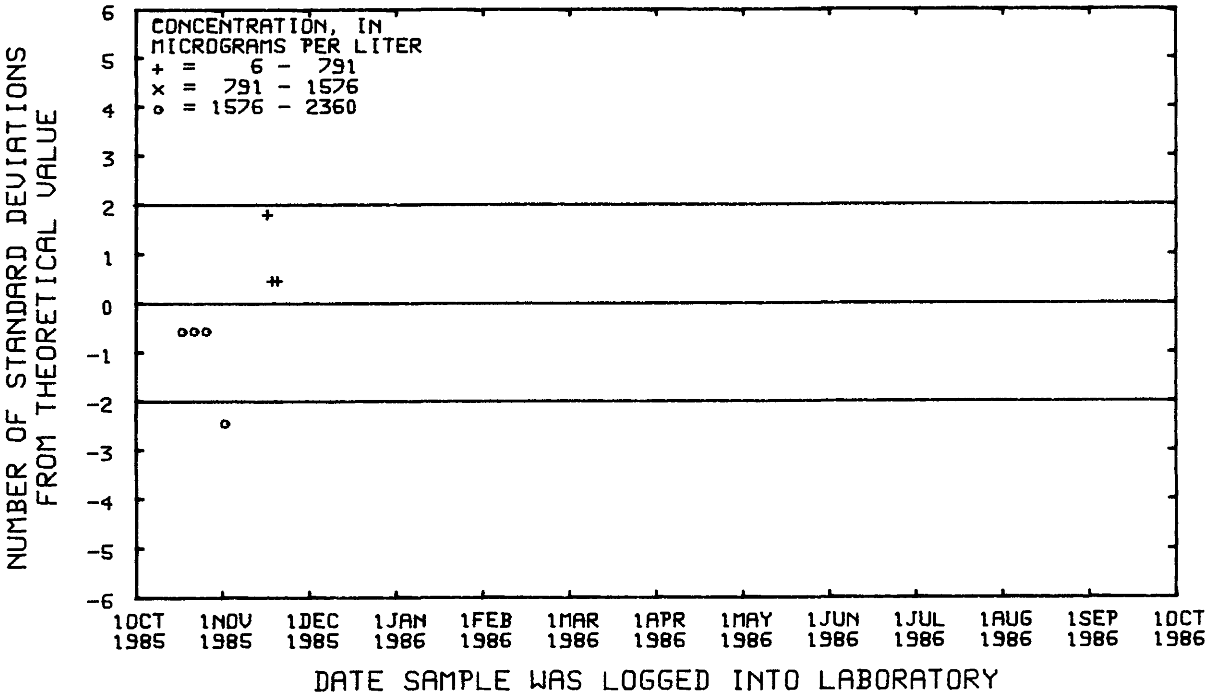


Figure 73.--Manganese, total recoverable, data from the Atlanta laboratory.

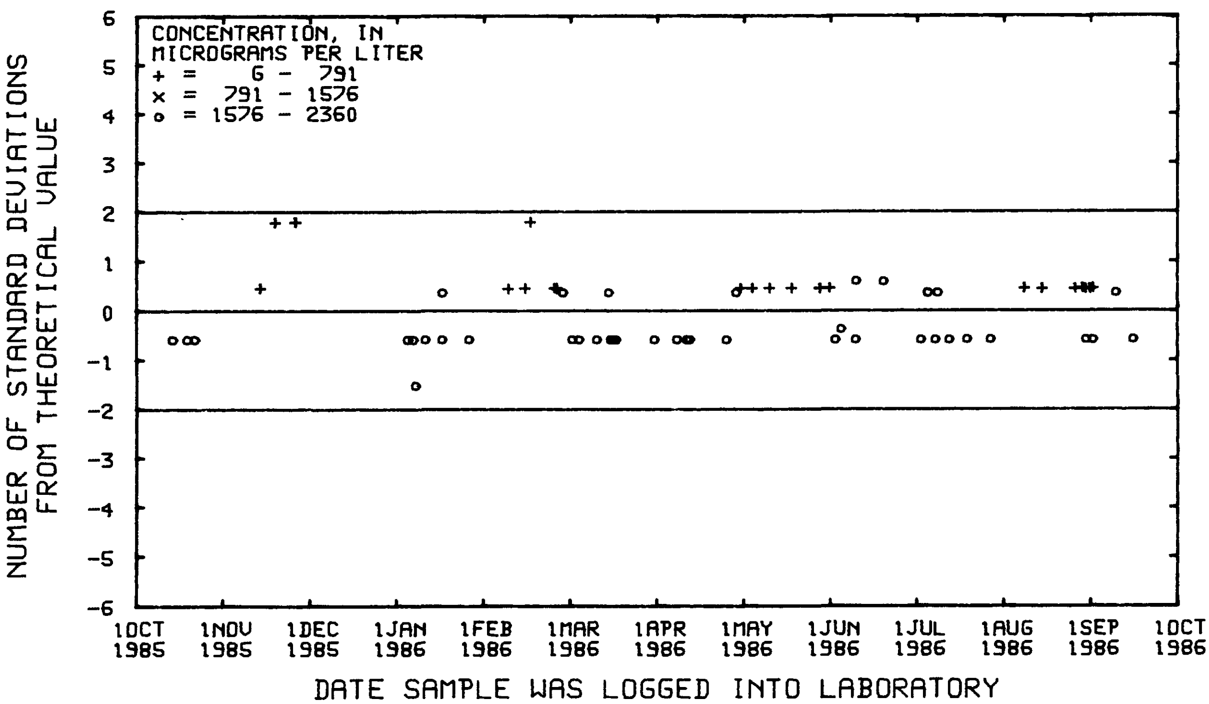


Figure 74.--Manganese, total recoverable, data from the Denver laboratory.

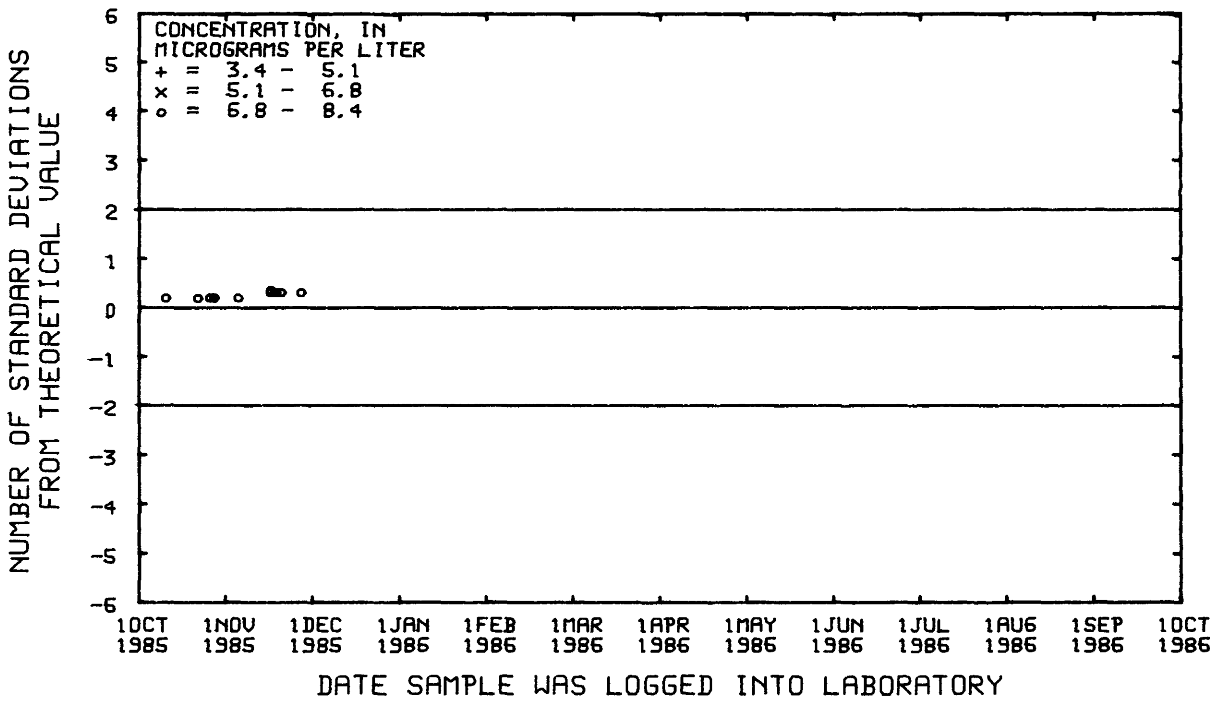


Figure 75.--Molybdenum, dissolved,
(inductively coupled plasma emission spectrometry)
data from the Atlanta laboratory.

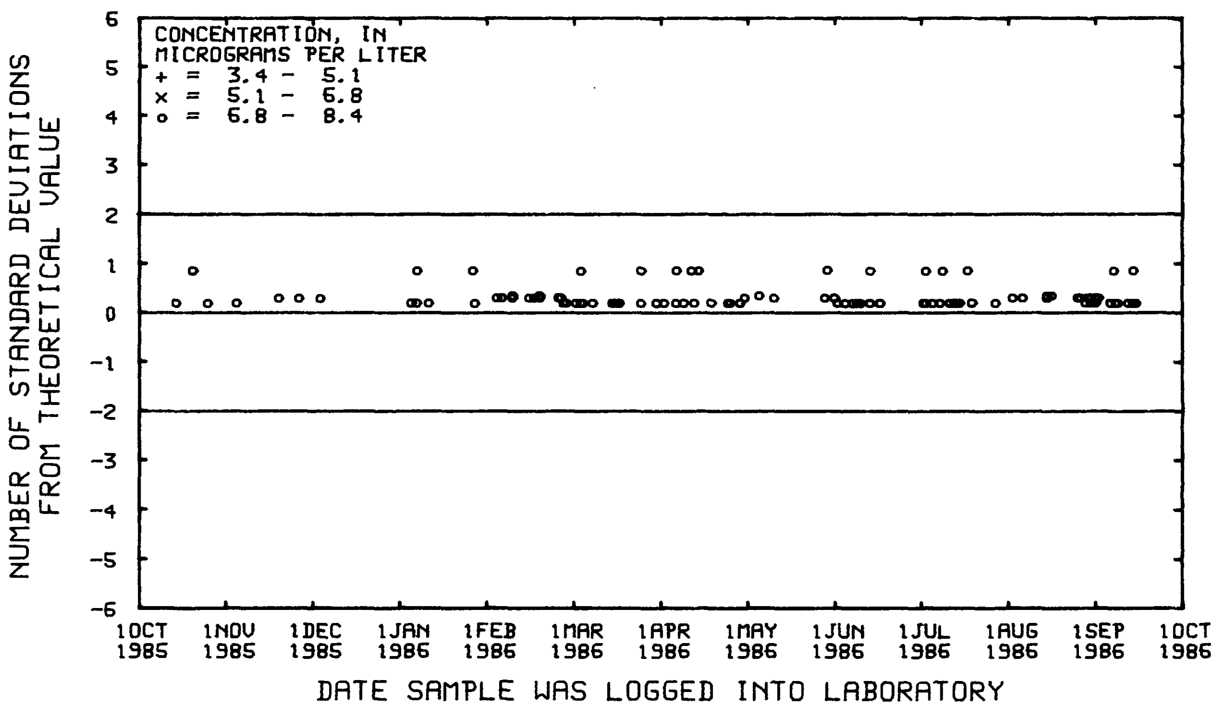


Figure 76.--Molybdenum, dissolved,
(inductively coupled plasma emission spectrometry)
data from the Denver laboratory.

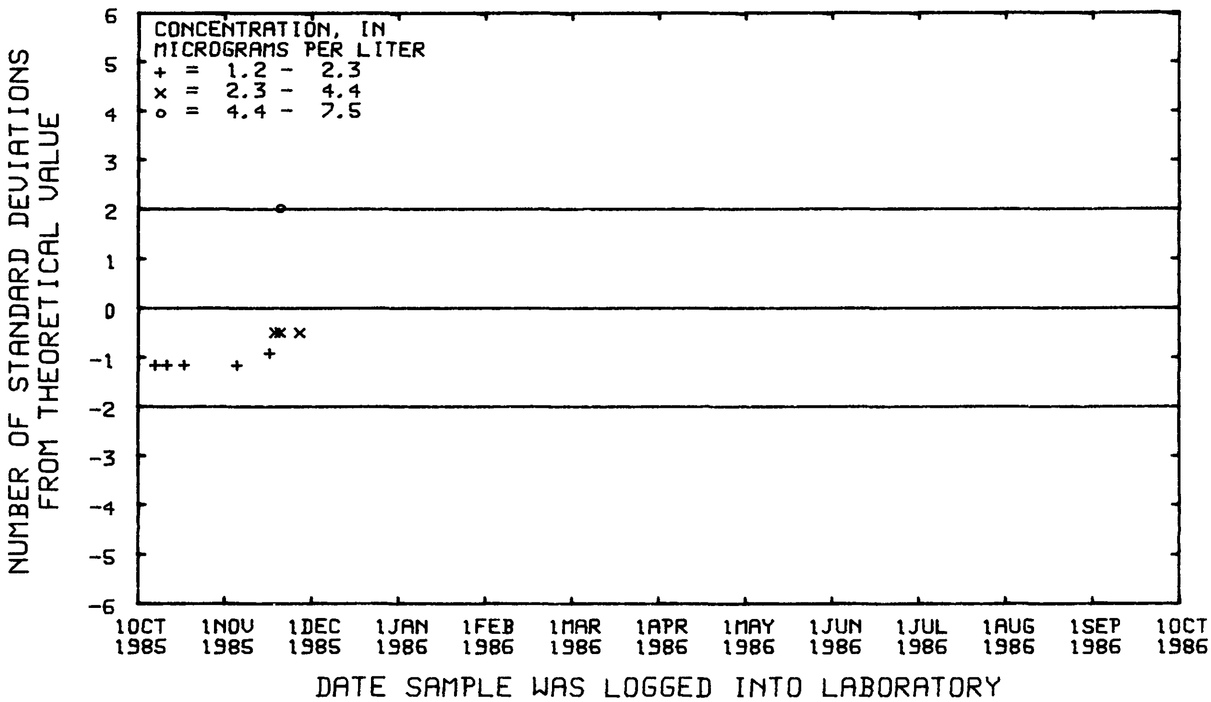


Figure 77.--Molybdenum, dissolved, (atomic absorption spectrometry) data from the Atlanta laboratory.

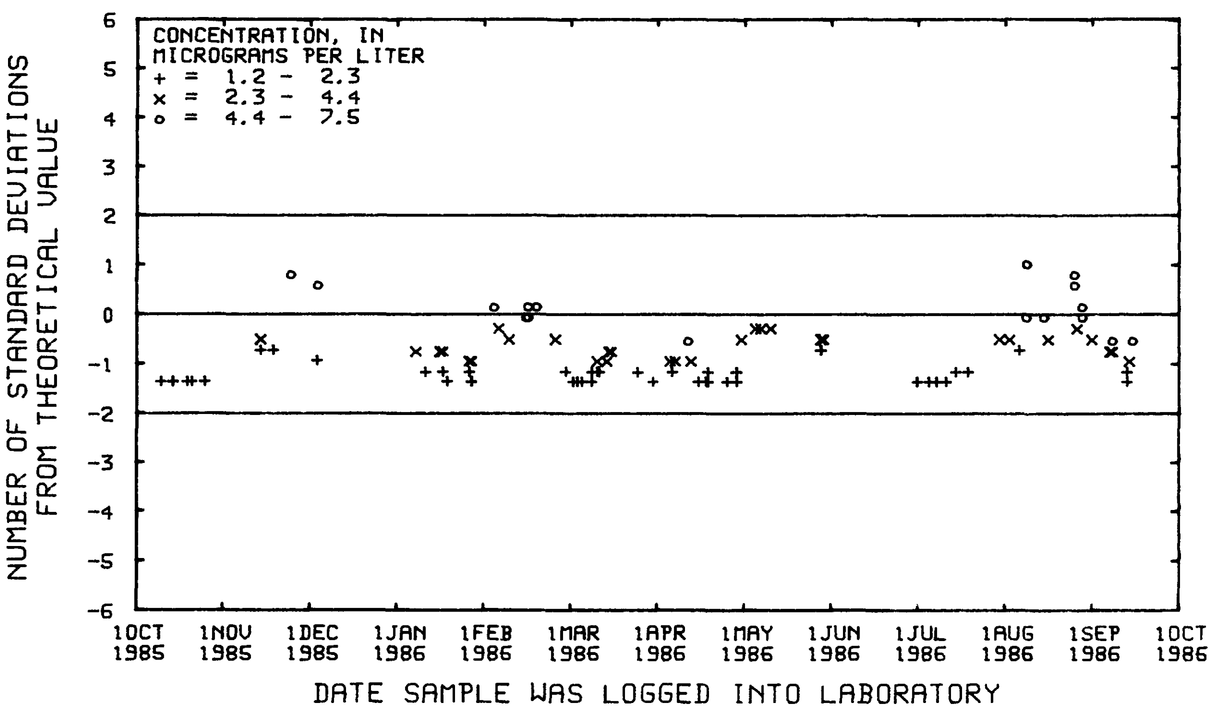


Figure 78.--Molybdenum, dissolved, (atomic absorption spectrometry) data from the Denver laboratory.

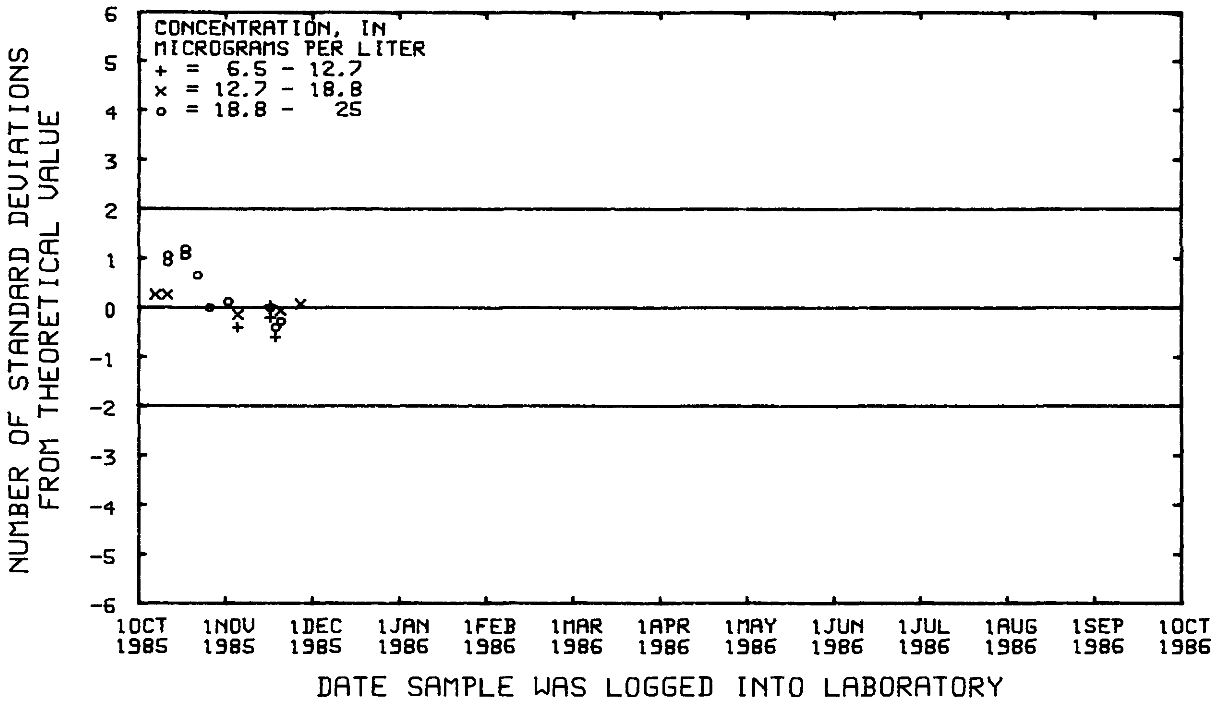


Figure 79.--Nickel, dissolved, data from the Atlanta laboratory.

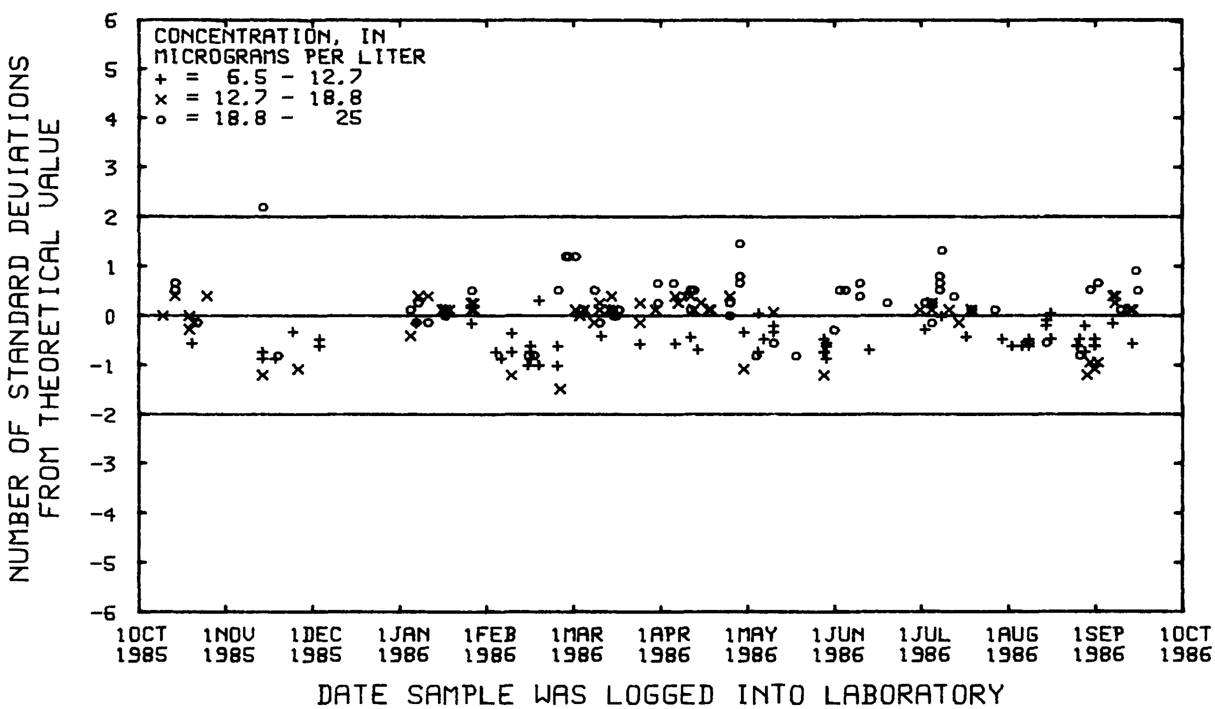


Figure 80.--Nickel, dissolved, data from the Denver laboratory.

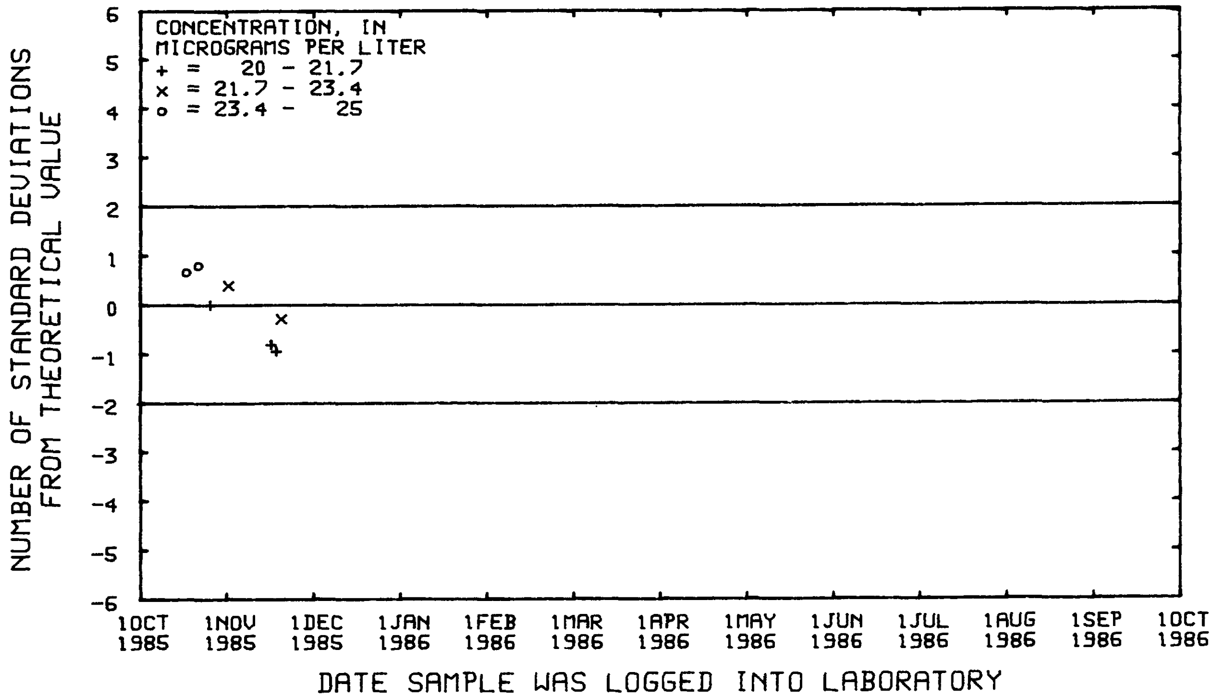


Figure 81.--Nickel, total recoverable, data from the Atlanta laboratory.

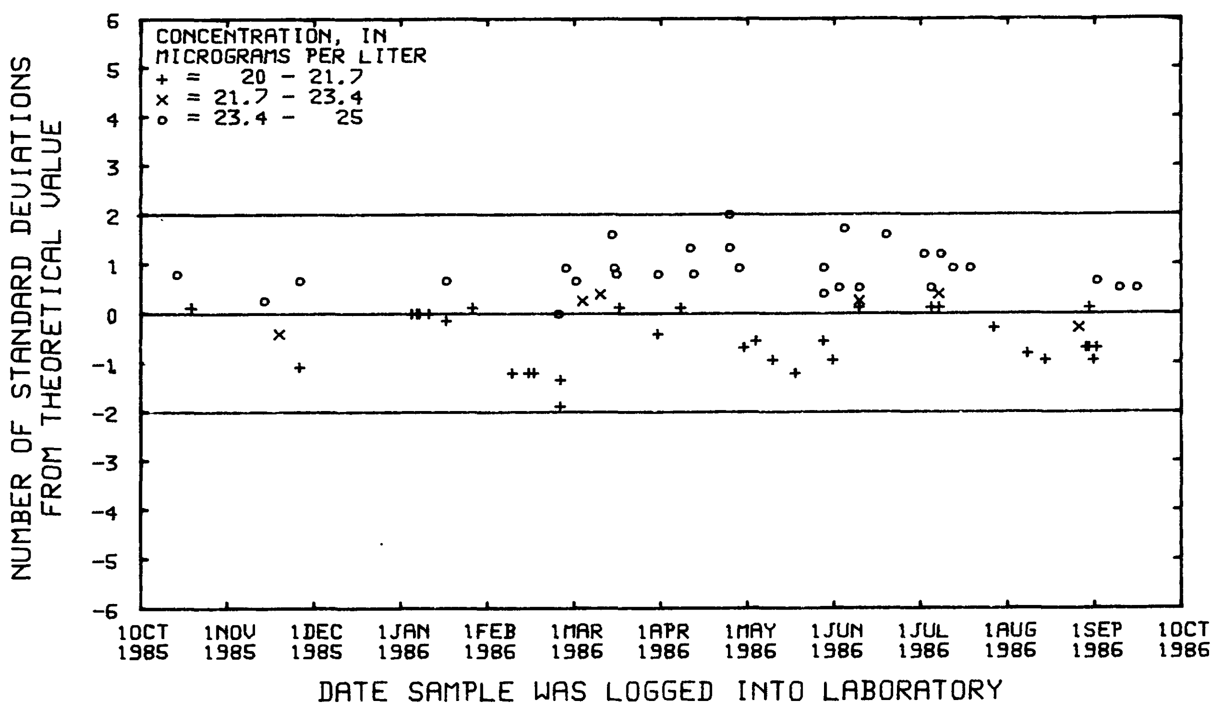


Figure 82.--Nickel, total recoverable, data from the Denver laboratory.

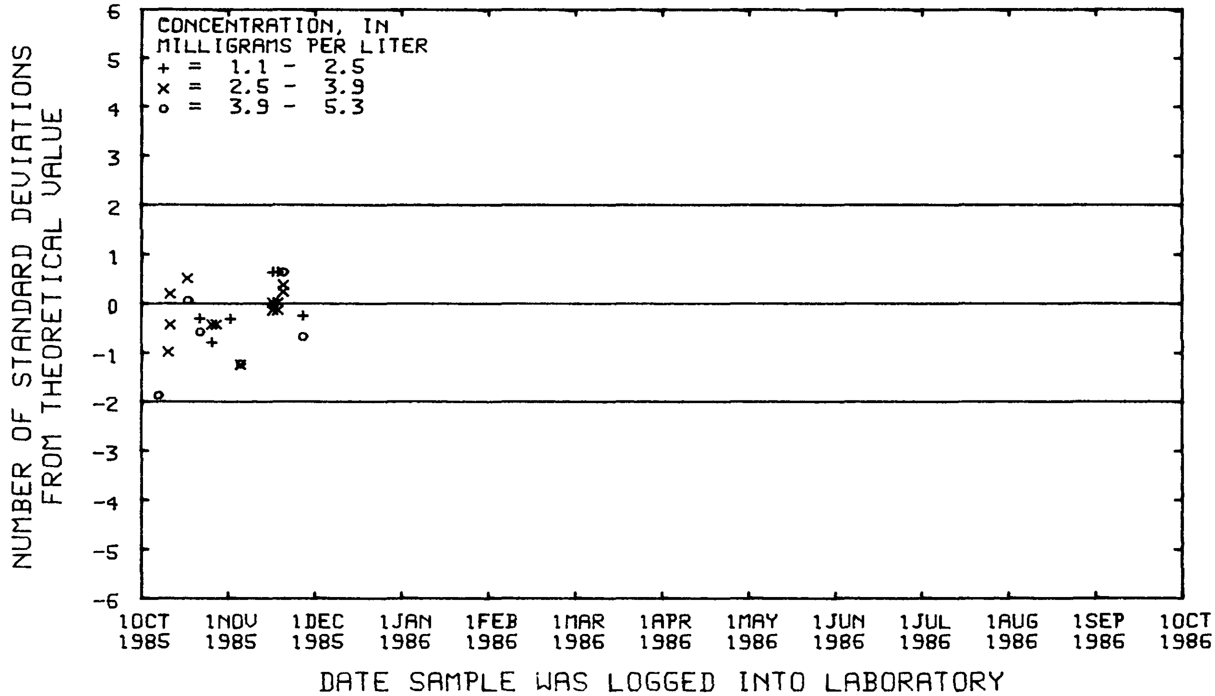


Figure 83.--Potassium, dissolved, data from the Atlanta laboratory.

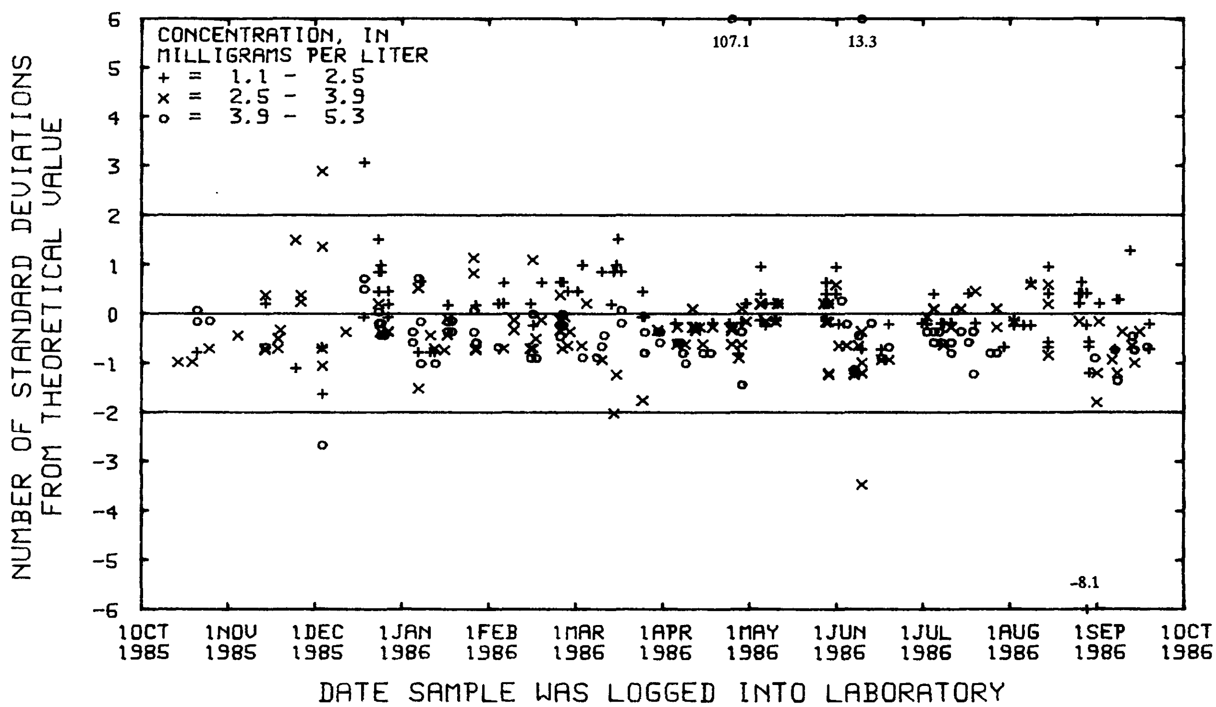


Figure 84.--Potassium, dissolved, data from the Denver laboratory.

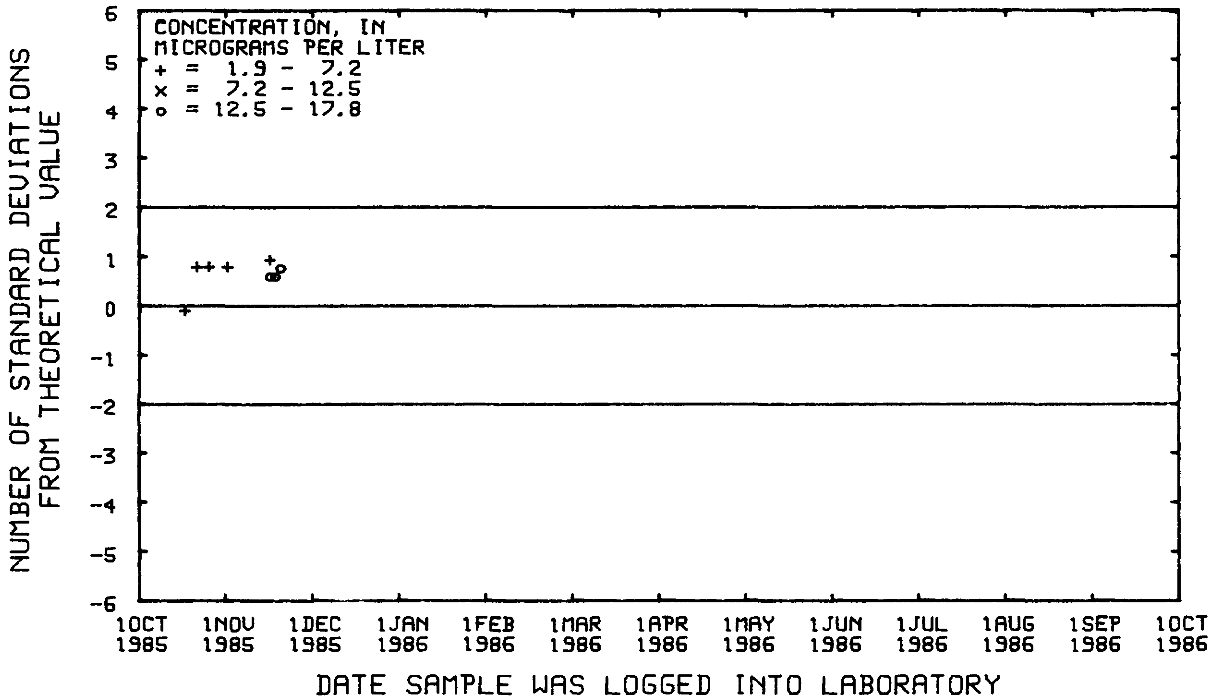


Figure 85.--Selenium, dissolved, data from the Atlanta laboratory.

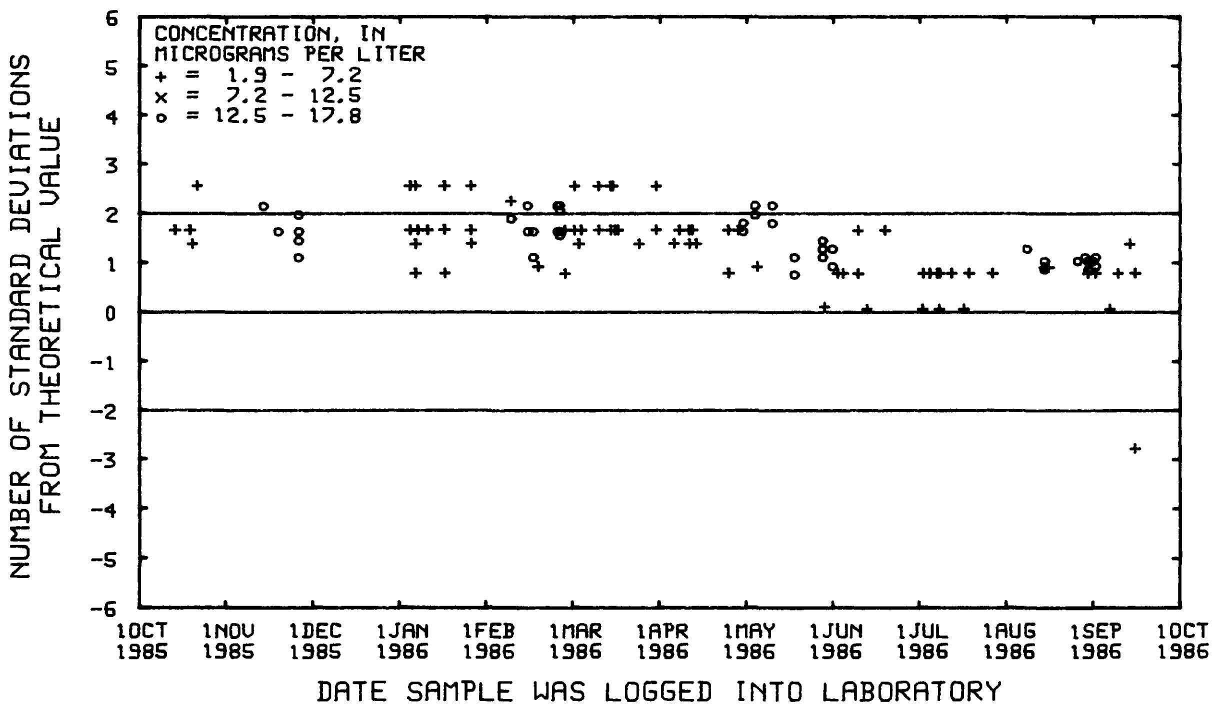


Figure 86.--Selenium, dissolved, data from the Denver laboratory.

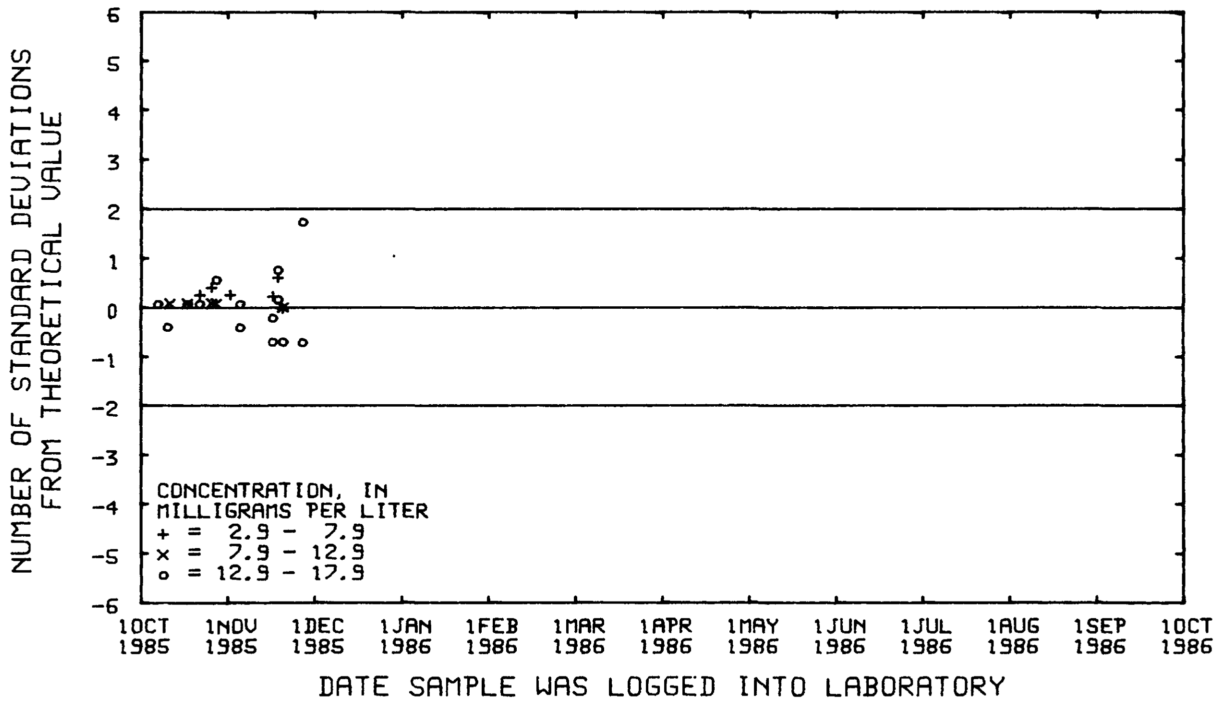


Figure 87.--Silica, dissolved, data from the Atlanta laboratory.

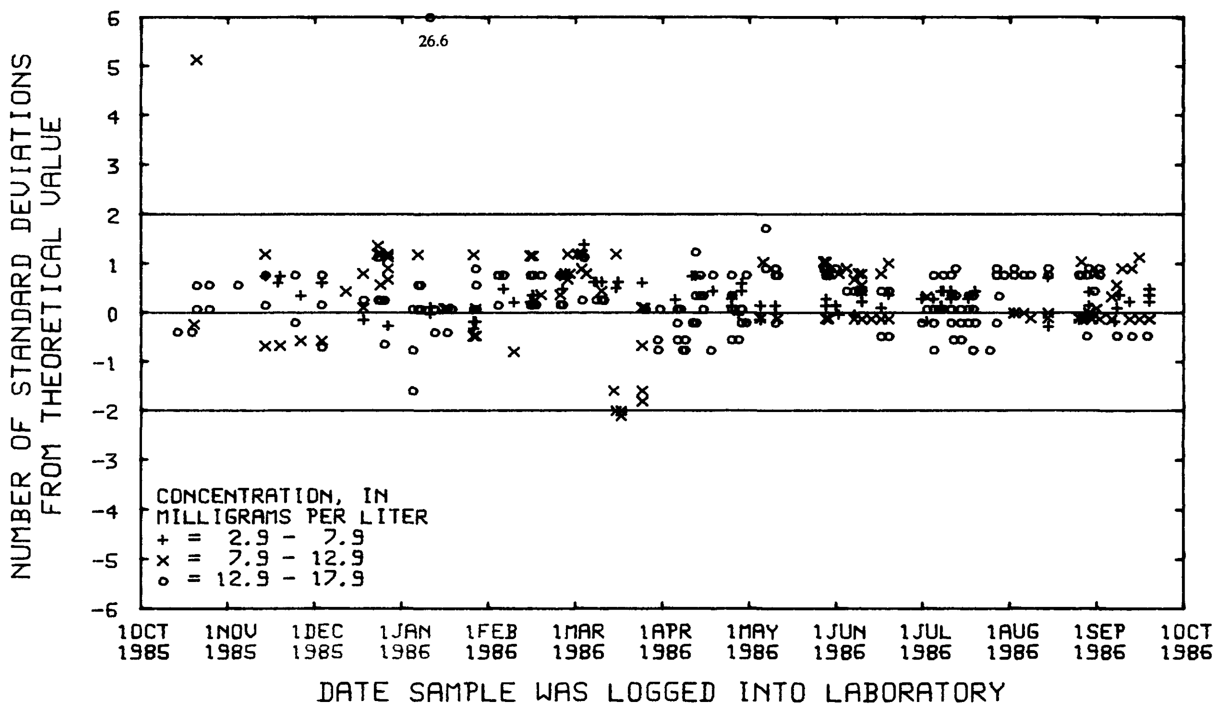


Figure 88.--Silica, dissolved, data from the Denver laboratory.

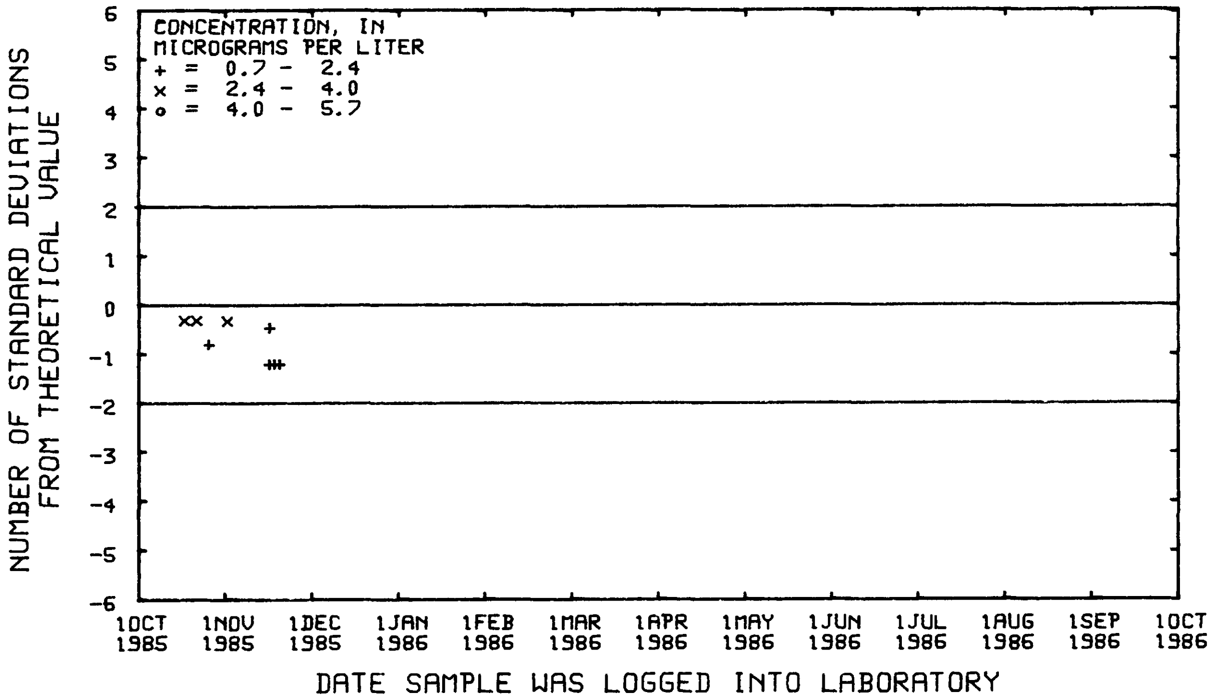


Figure 89.--Silver, dissolved, data from the Atlanta laboratory.

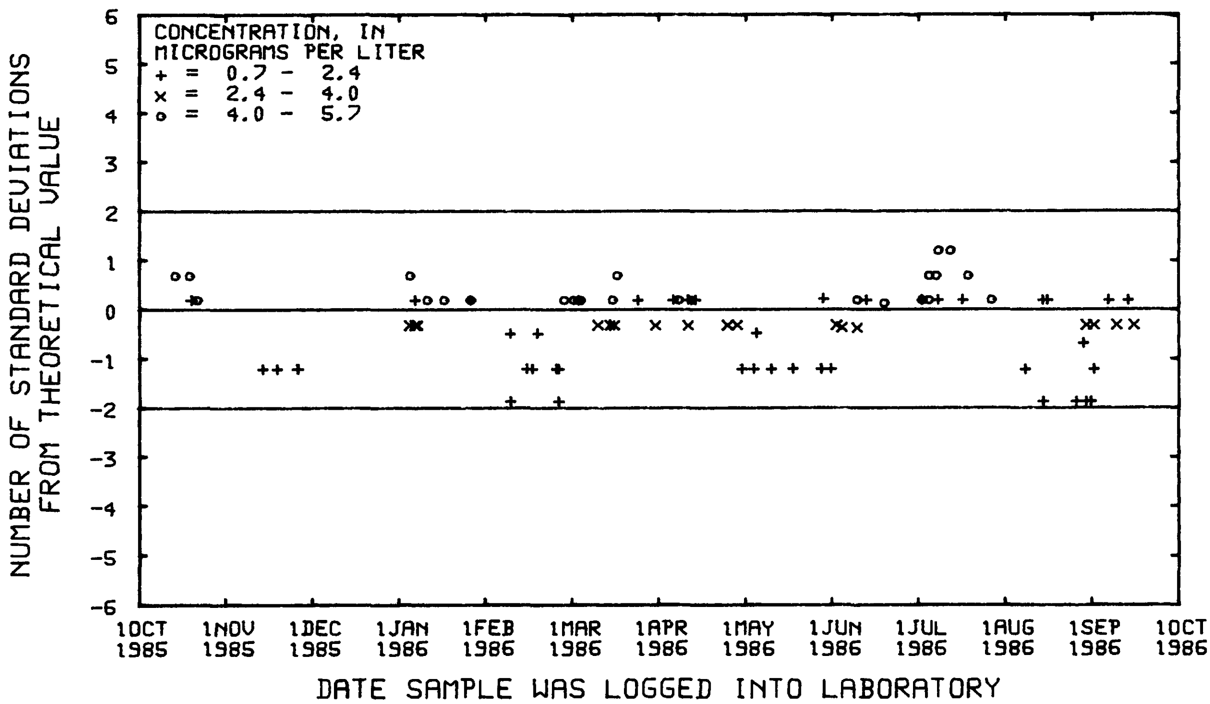


Figure 90.--Silver, dissolved, data from the Denver laboratory.

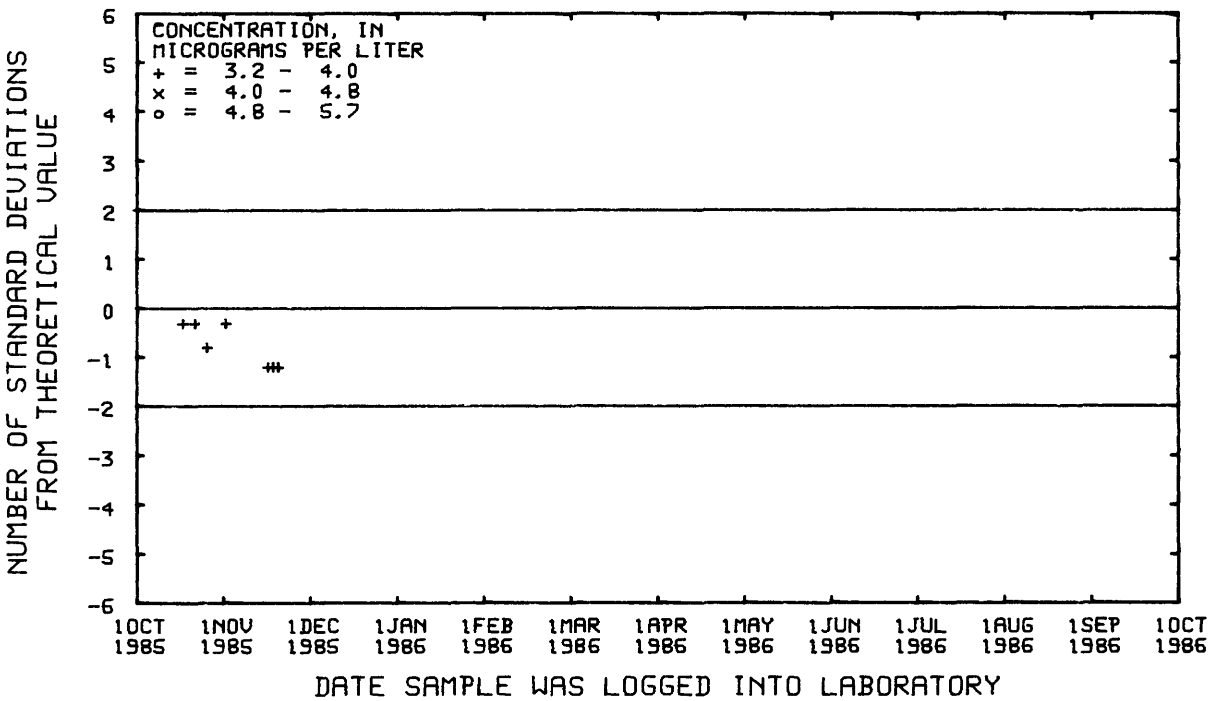


Figure 91.--Silver, total recoverable, data from the Atlanta laboratory.

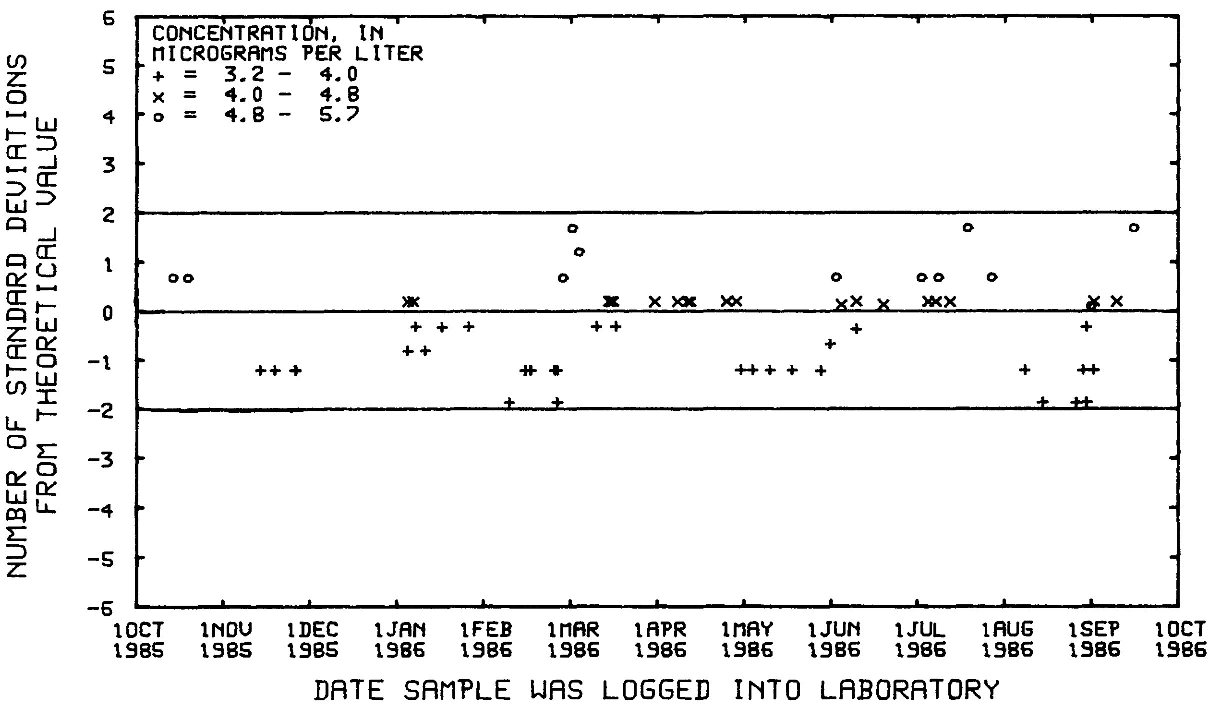


Figure 92.--Silver, total recoverable, data from the Denver laboratory.

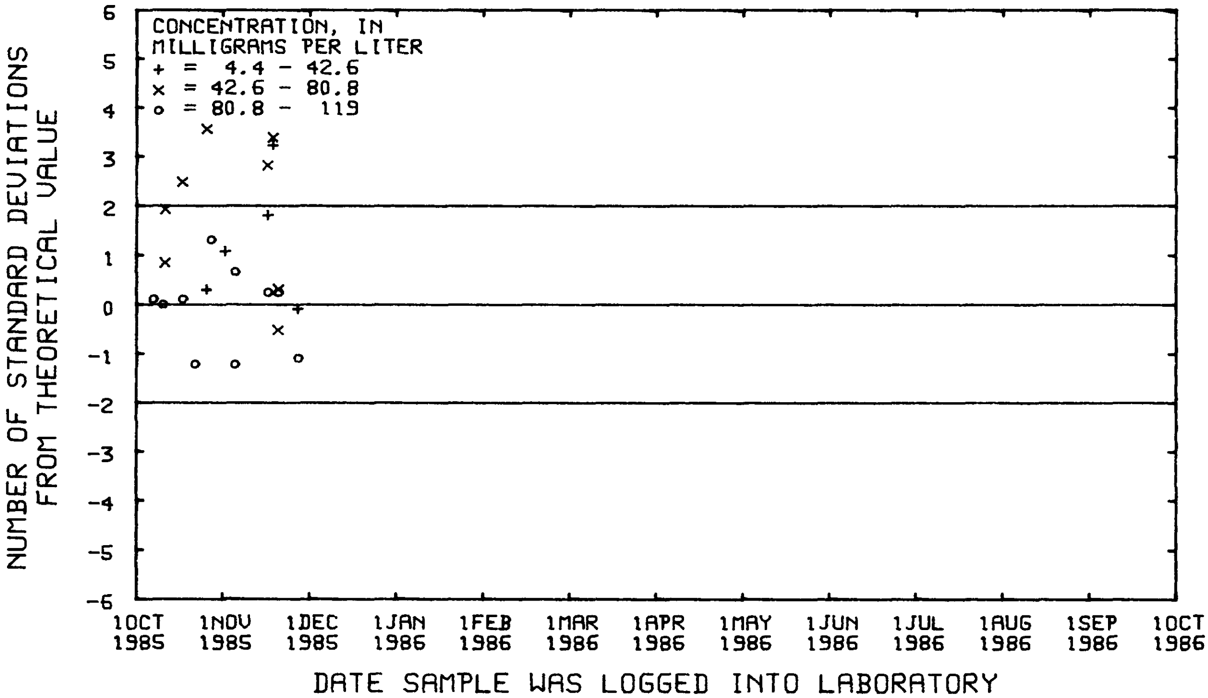


Figure 93.--Sodium, dissolved,
(inductively coupled plasma emission spectrometry)
data from the Atlanta laboratory.

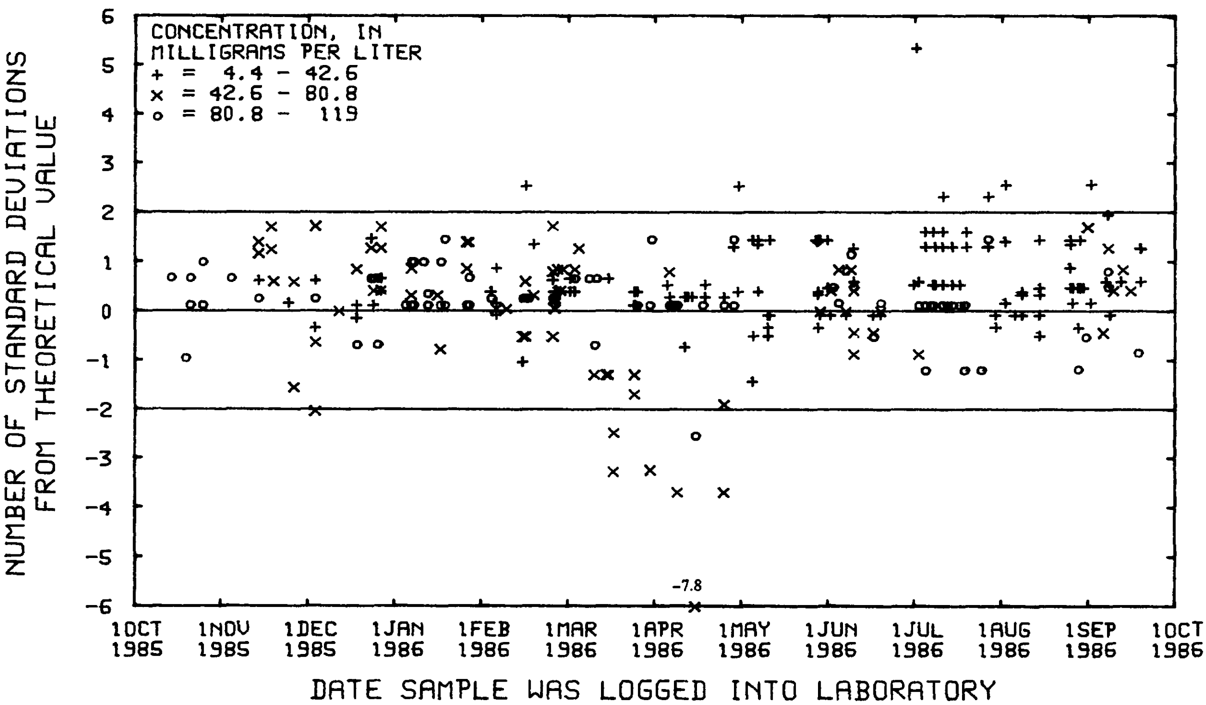


Figure 94.--Sodium, dissolved,
(inductively coupled plasma emission spectrometry)
data from the Denver laboratory.

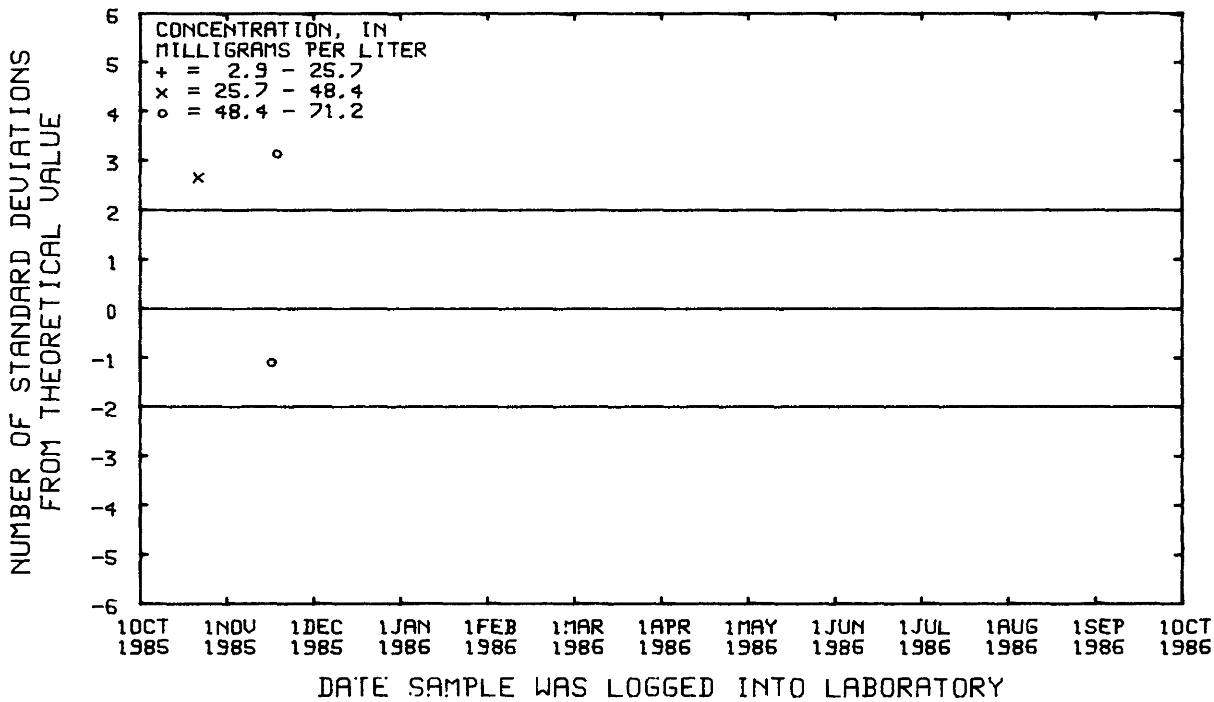


Figure 95.--Sodium, dissolved, (atomic absorption spectrometry) data from the Atlanta laboratory.

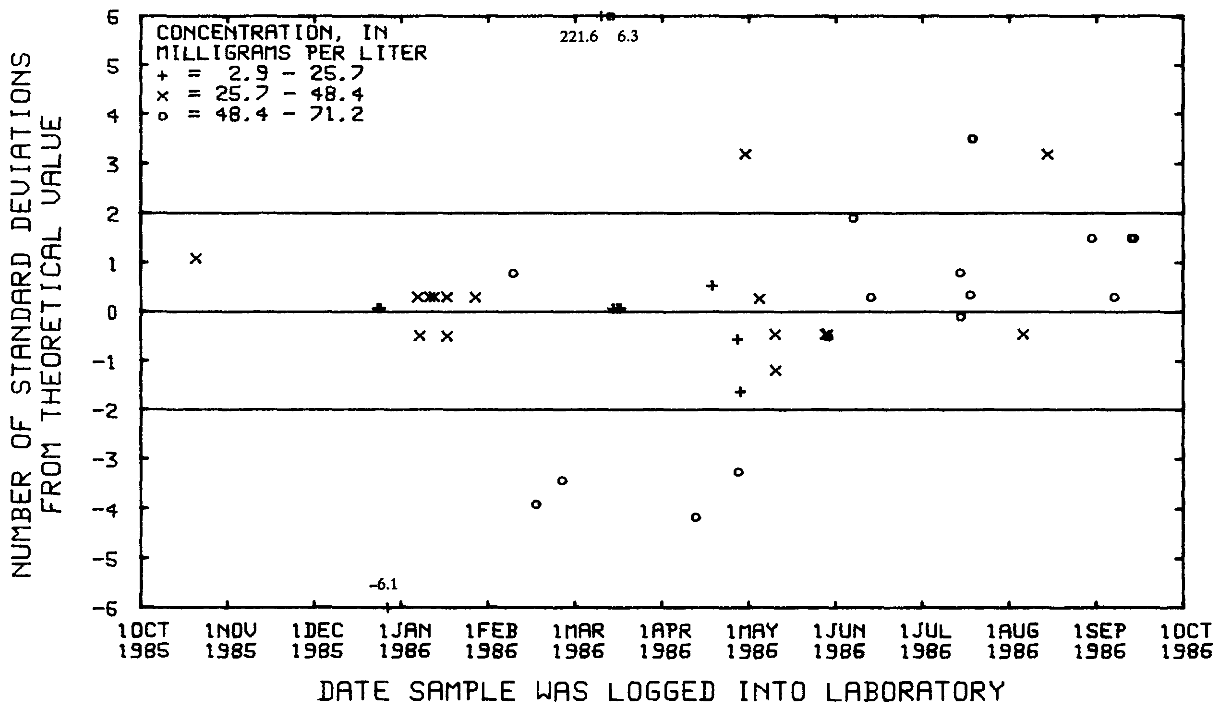


Figure 96.--Sodium, dissolved, (atomic absorption spectrometry) data from the Denver laboratory.

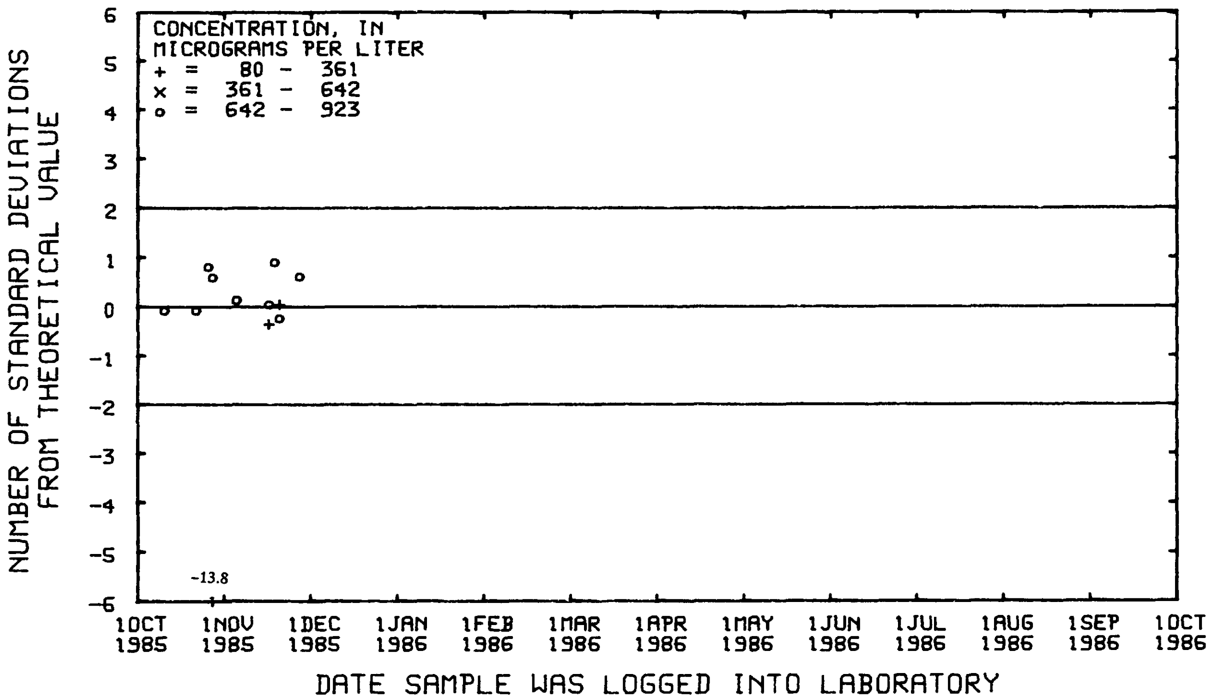


Figure 97.--Strontium, dissolved, data from the Atlanta laboratory.

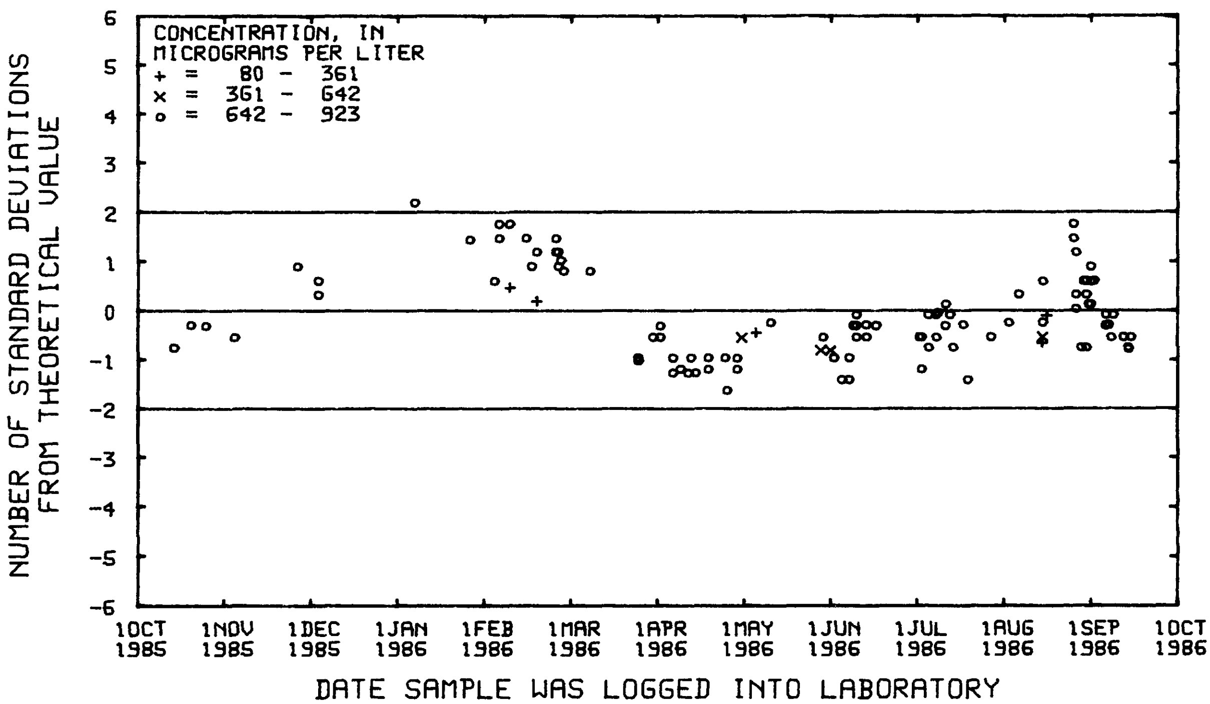


Figure 98.--Strontium, dissolved, data from the Denver laboratory.

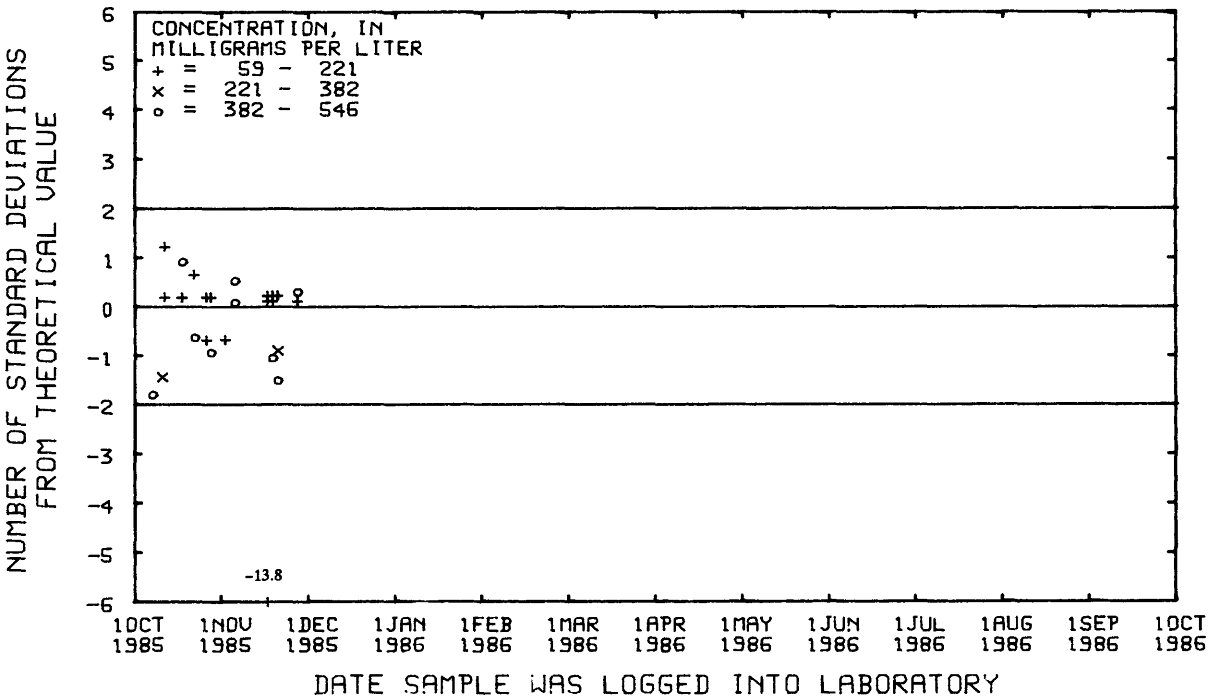


Figure 99--Sulfate, dissolved, data from the Atlanta laboratory.

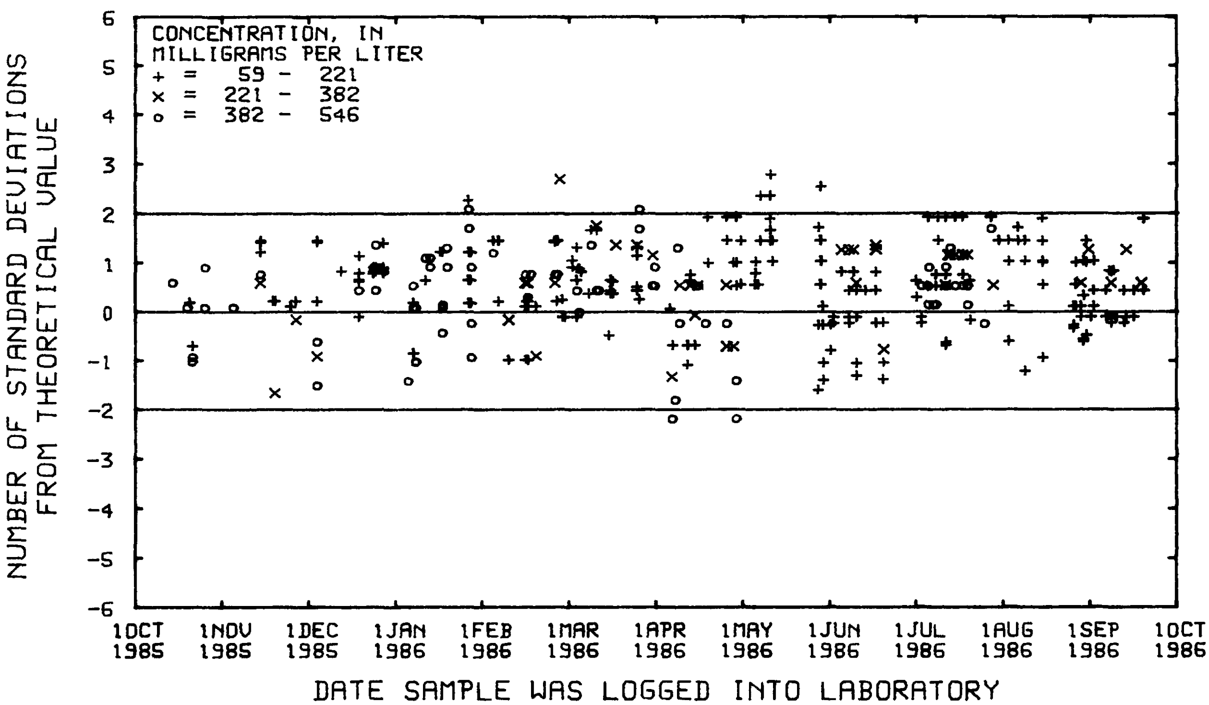


Figure 100--Sulfate, dissolved, data from the Denver laboratory.

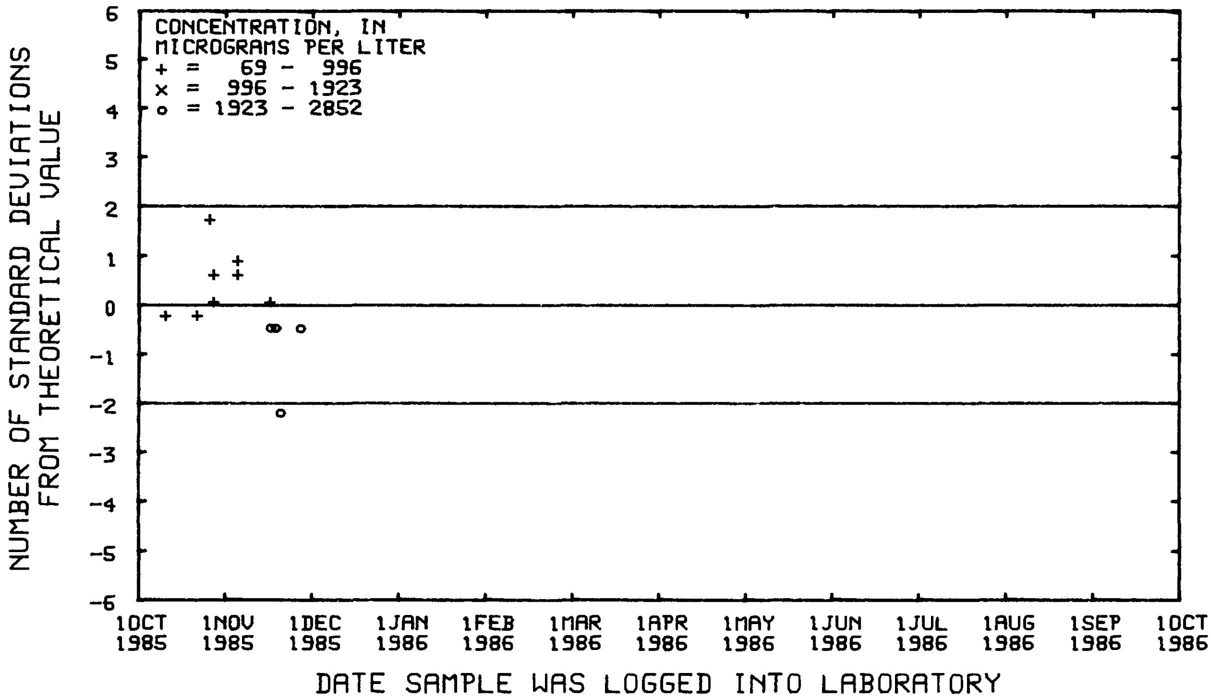


Figure 101.--Zinc, dissolved, (inductively coupled plasma emission spectrometry) data from the Atlanta laboratory.

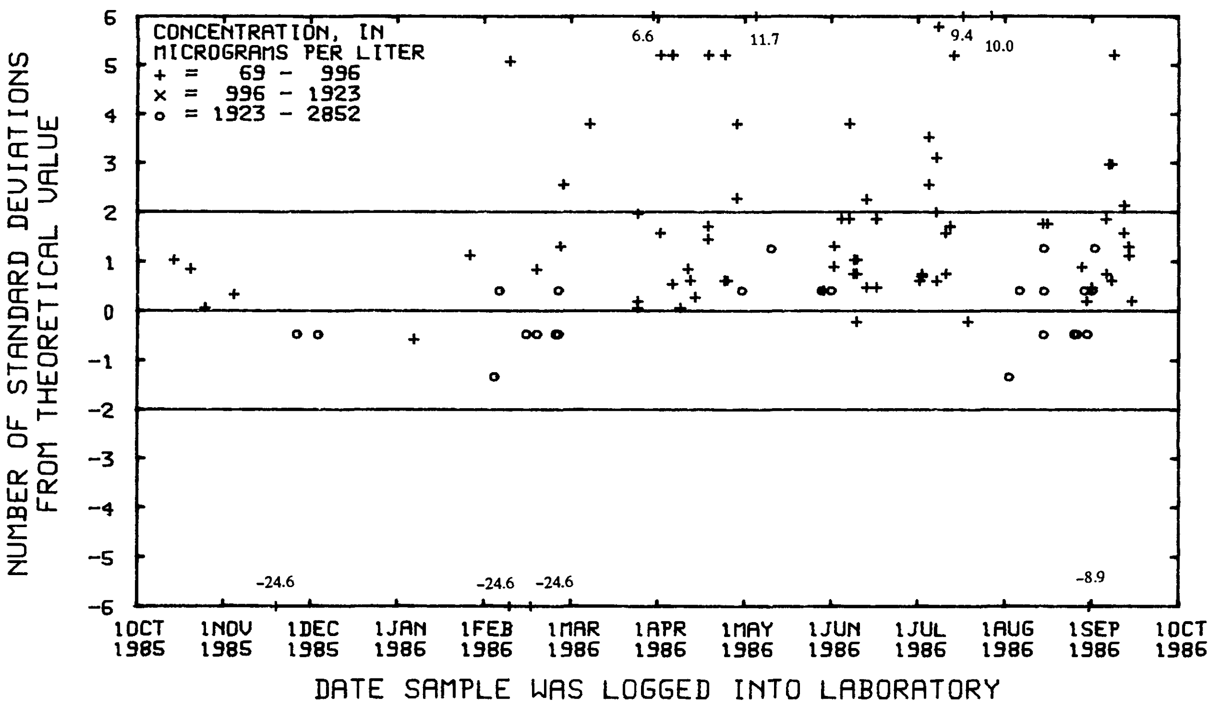


Figure 102.--Zinc, dissolved, (inductively coupled plasma emission spectrometry) data from the Denver laboratory.

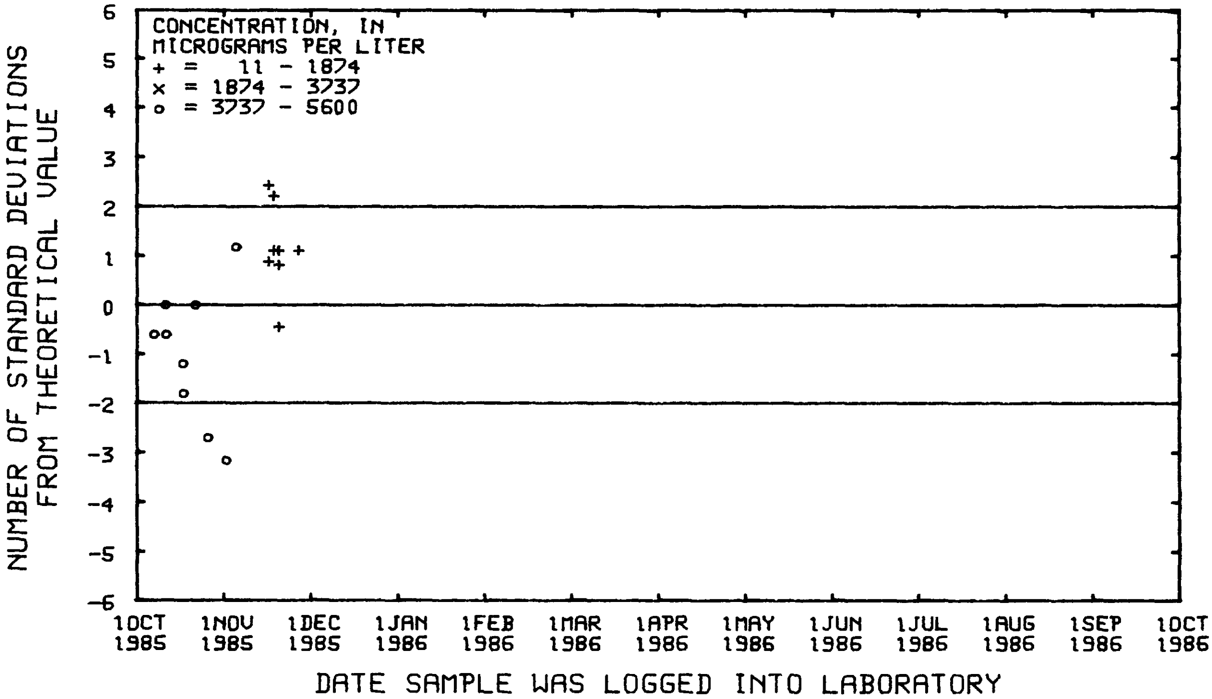


Figure 103.--Zinc, dissolved, (atomic absorption spectrometry) data from the Atlanta laboratory.

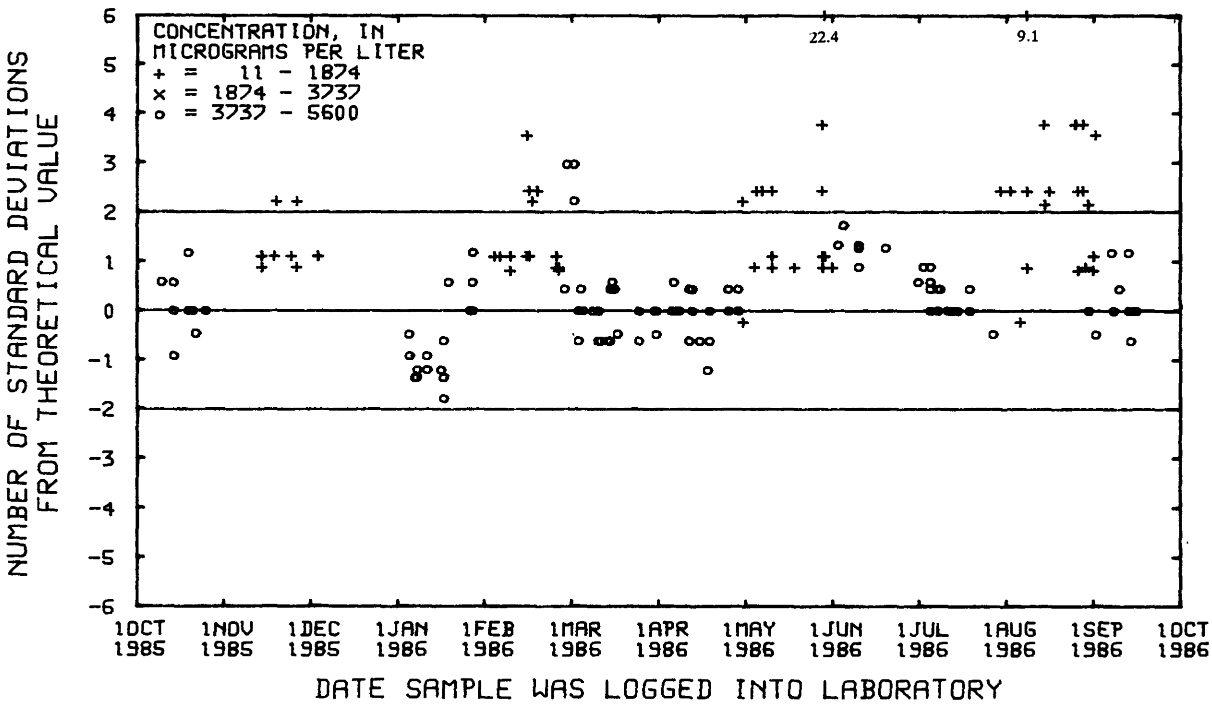


Figure 104.--Zinc, dissolved, (atomic absorption spectrometry) data from the Denver laboratory.

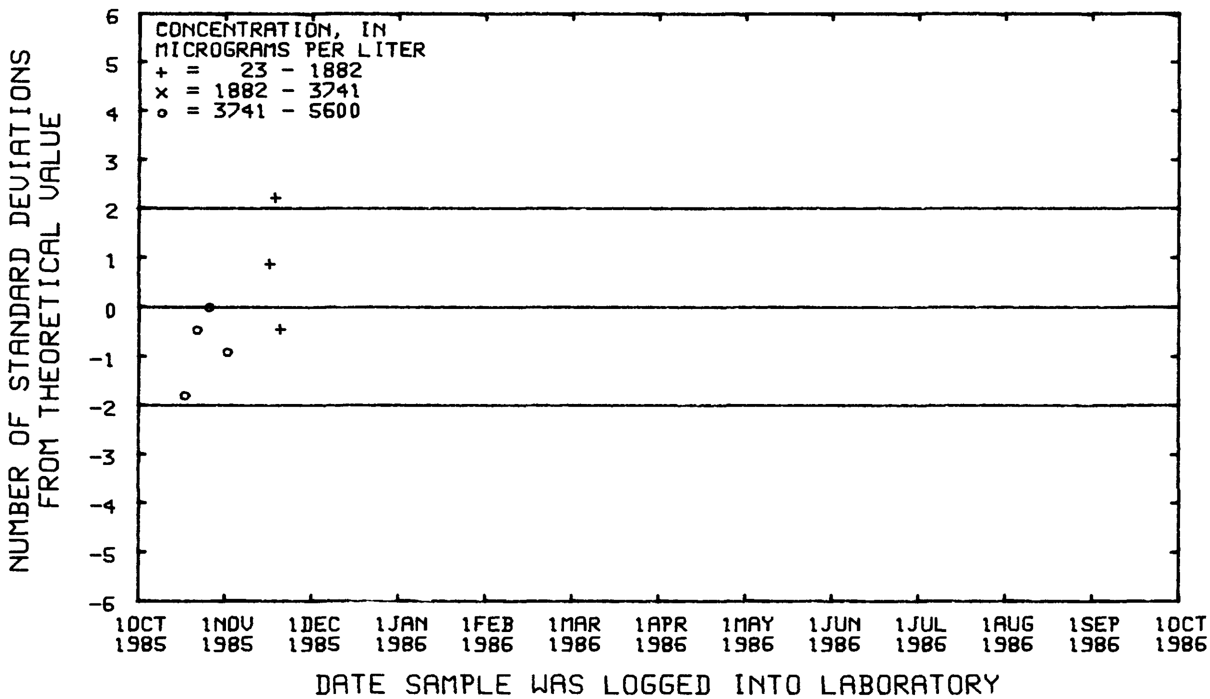


Figure 105.--Zinc, total recoverable, data from the Atlanta laboratory.

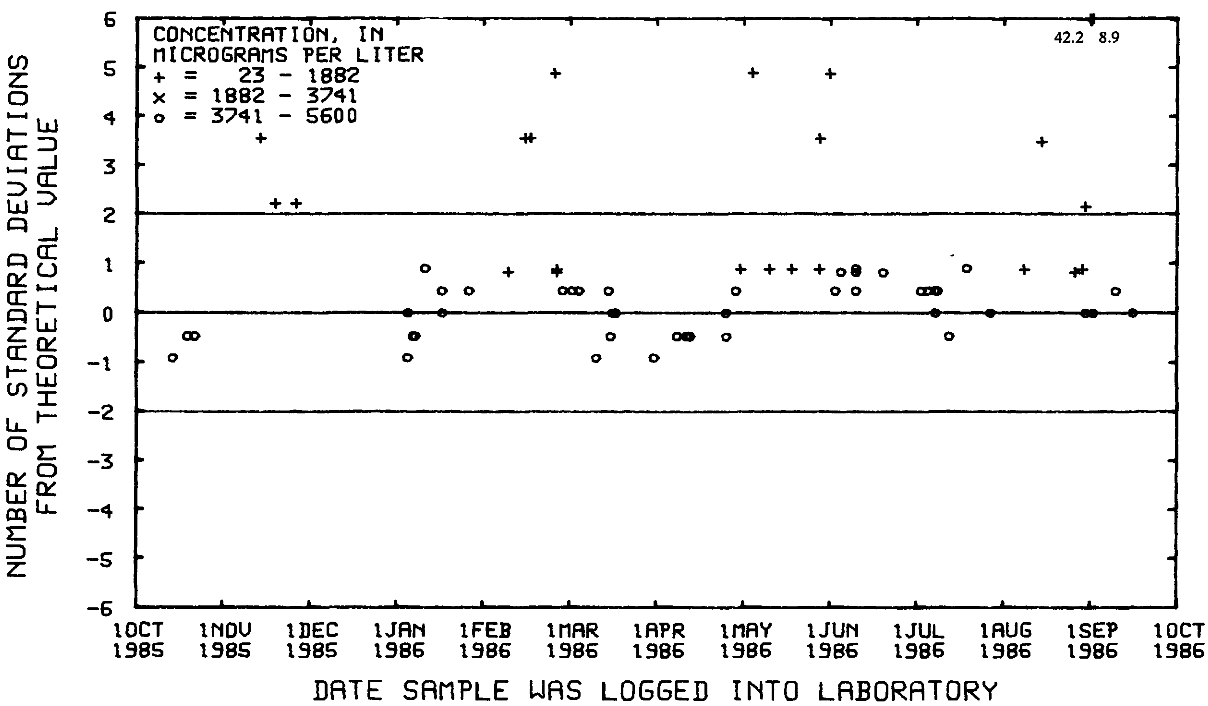


Figure 106.--Zinc, total recoverable, data from the Denver laboratory.

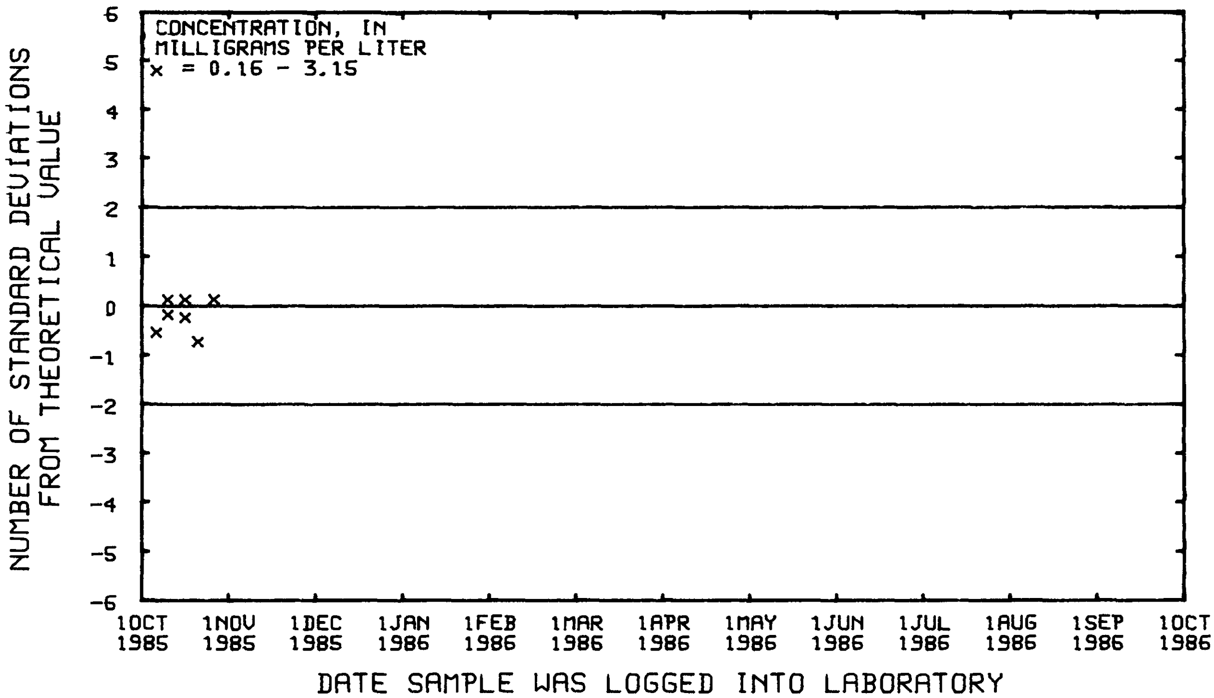


Figure 107.--Ammonia nitrogen as N, dissolved, data from the Atlanta laboratory.

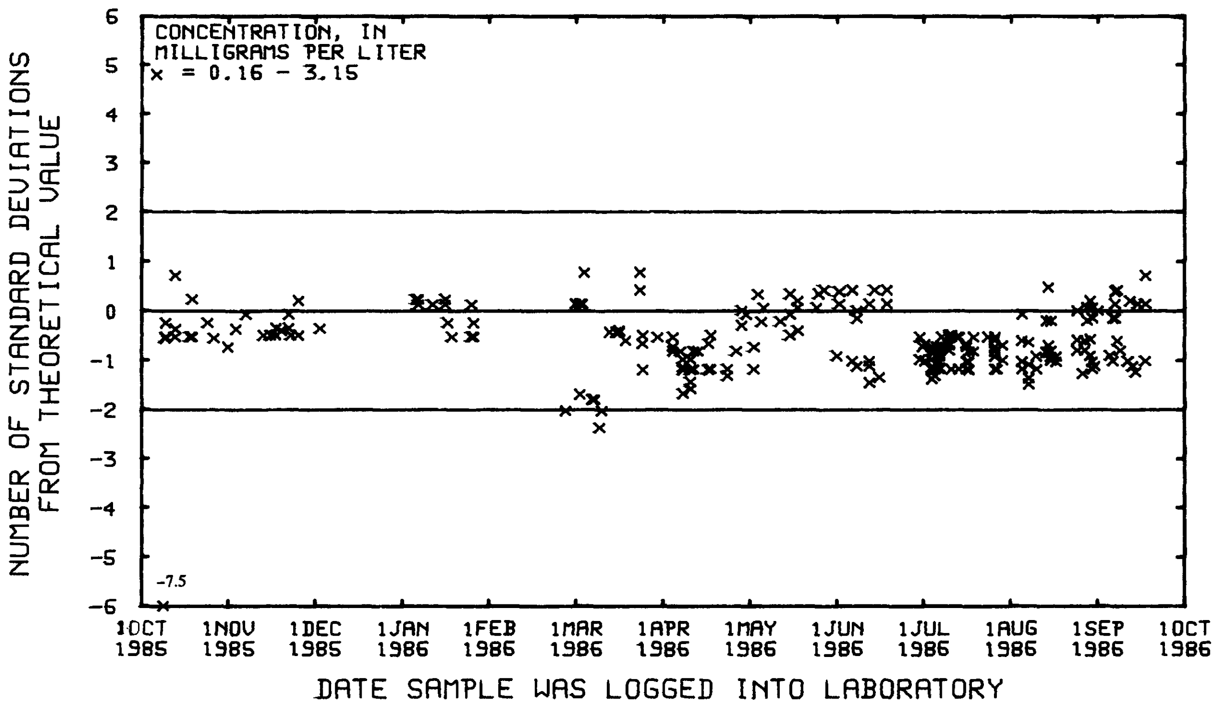


Figure 108.--Ammonia nitrogen as N, dissolved, data from the Denver laboratory.

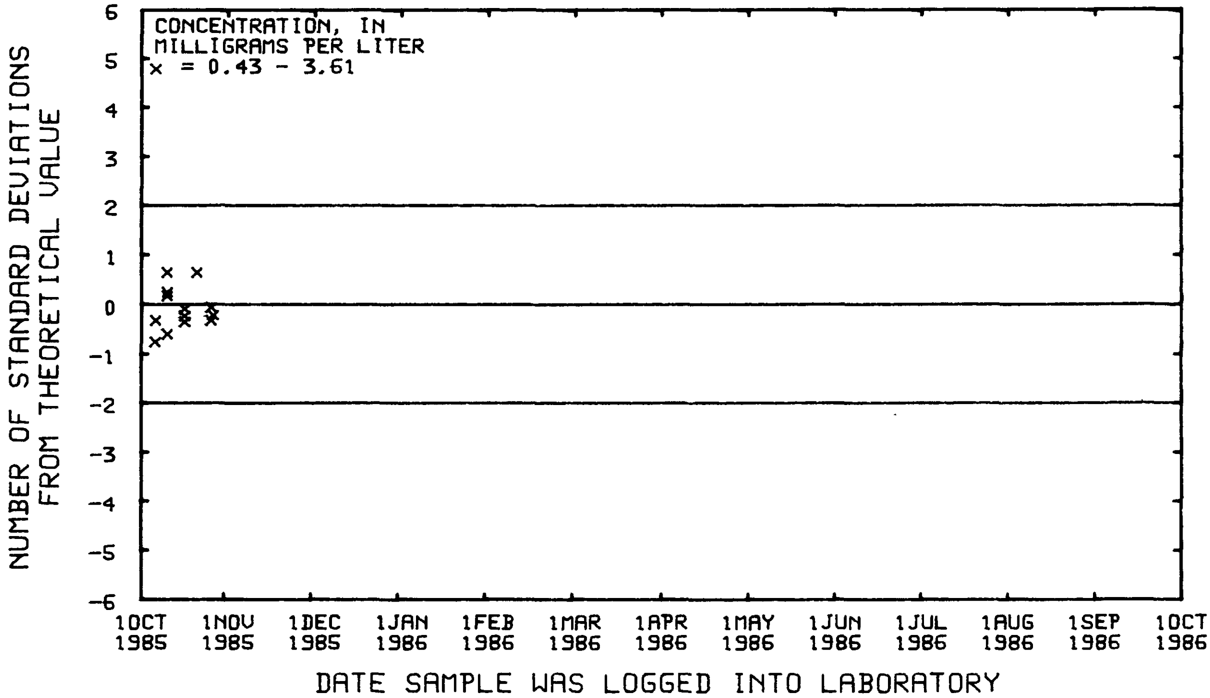


Figure 109.--Ammonia + organic nitrogen as N, dissolved, data from the Atlanta laboratory.

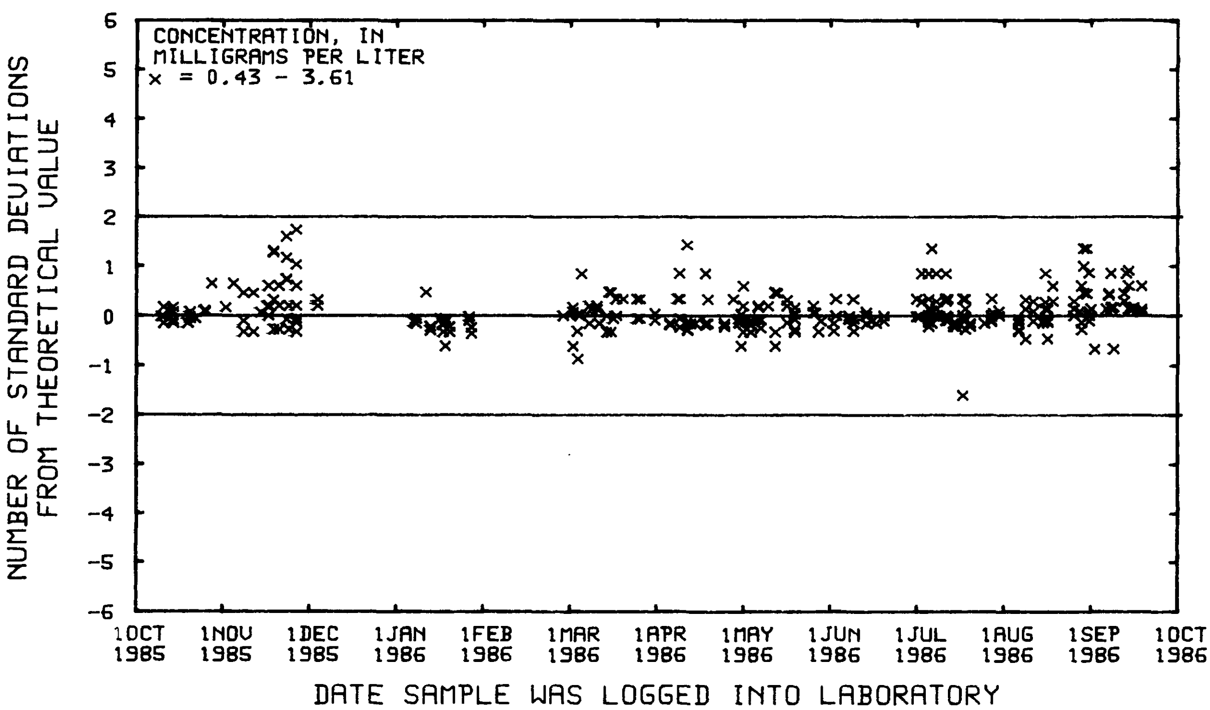


Figure 110.--Ammonia + organic nitrogen as N, dissolved, data from the Denver laboratory.

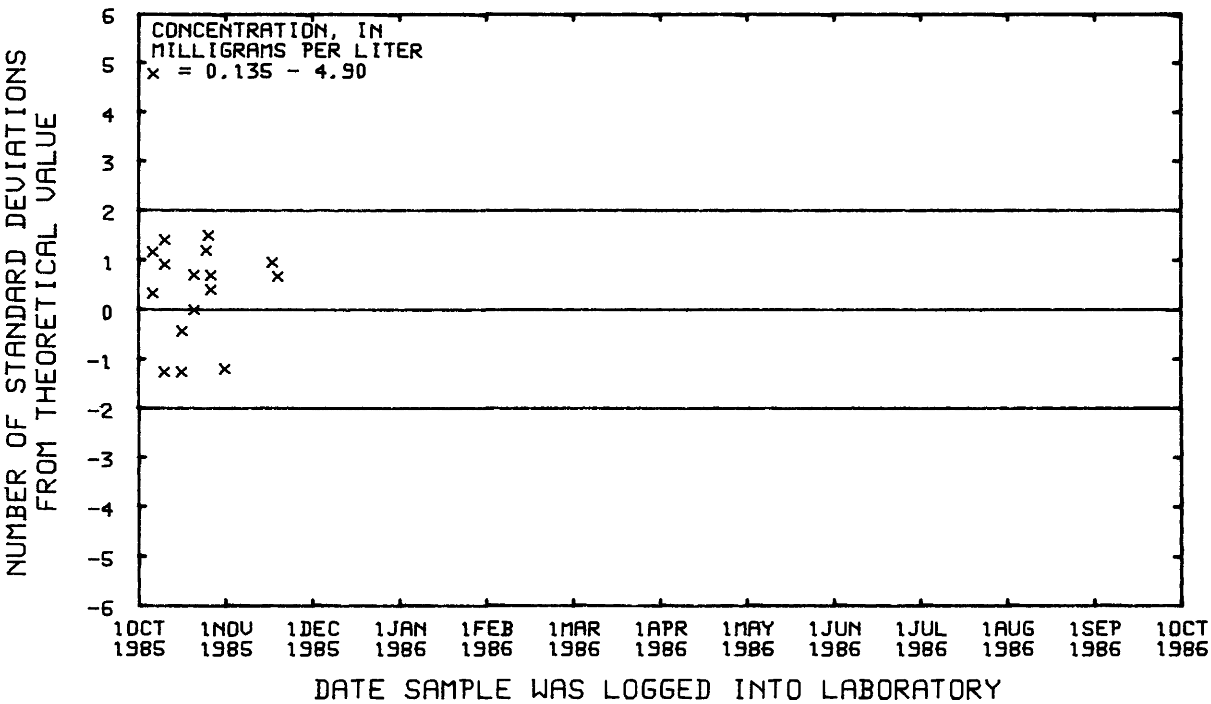


Figure 111.--Nitrite + nitrate nitrogen as N, dissolved, data from the Atlanta laboratory.

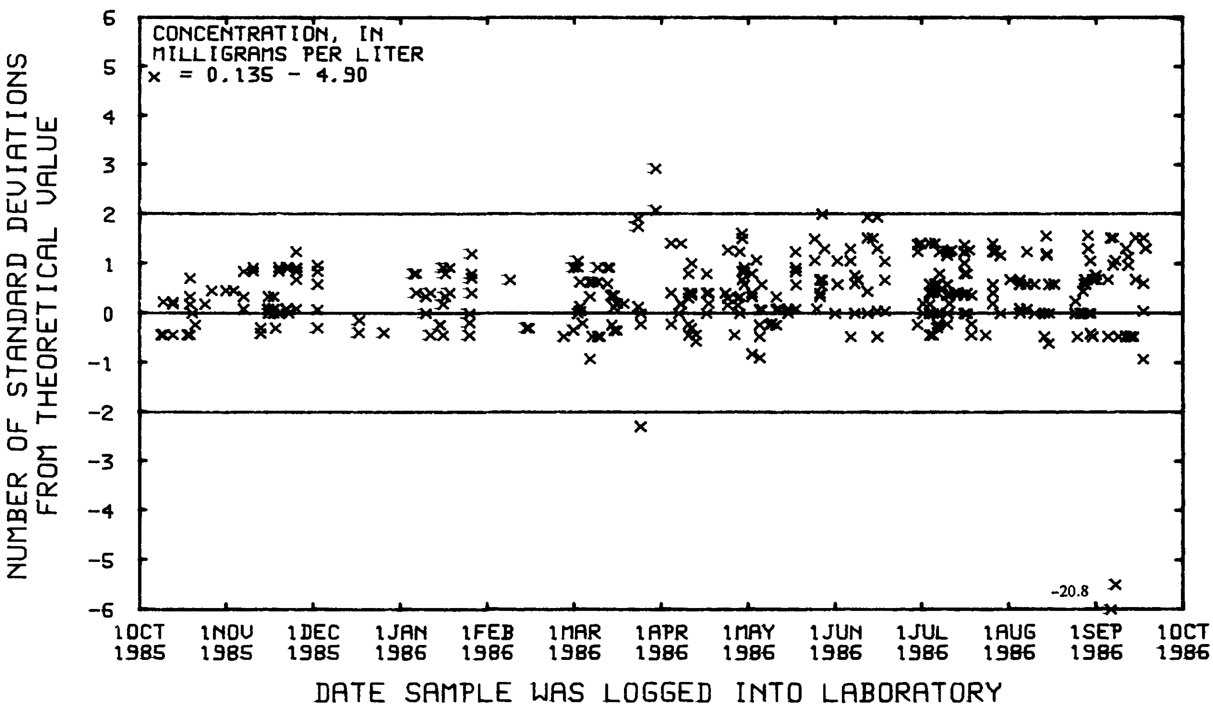


Figure 112.--Nitrite + nitrate nitrogen as N, dissolved, data from the Denver laboratory.

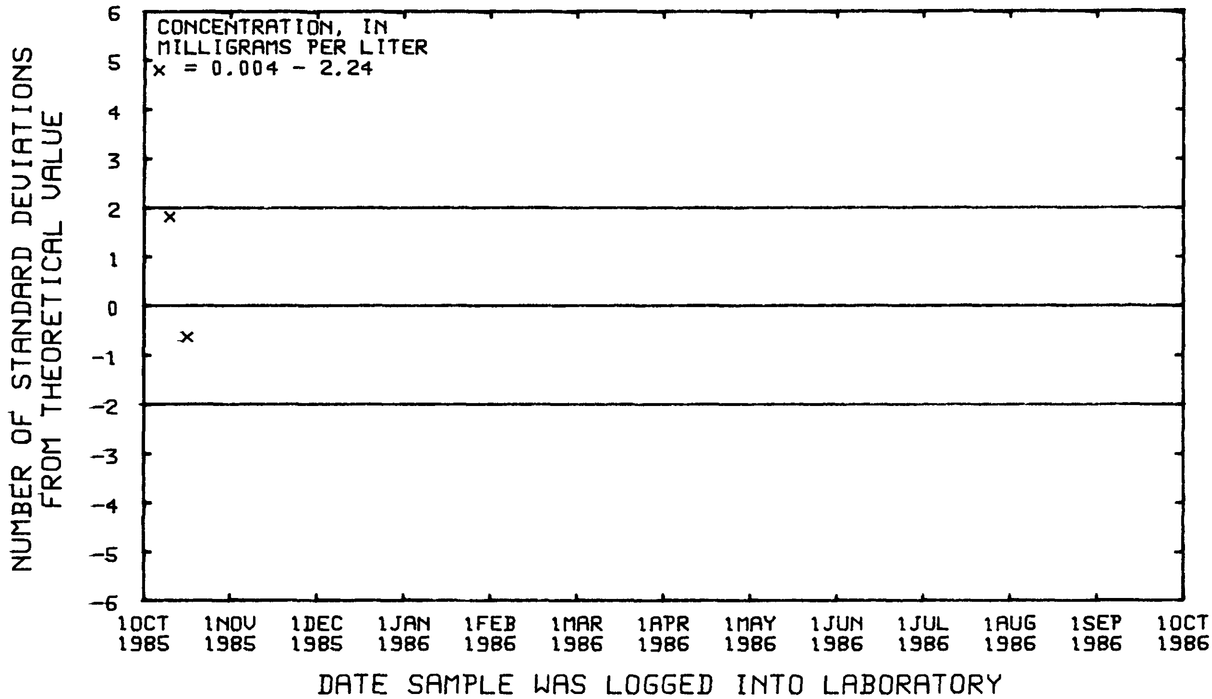


Figure 113.--Nitrite nitrogen as N, dissolved, data from the Atlanta laboratory.

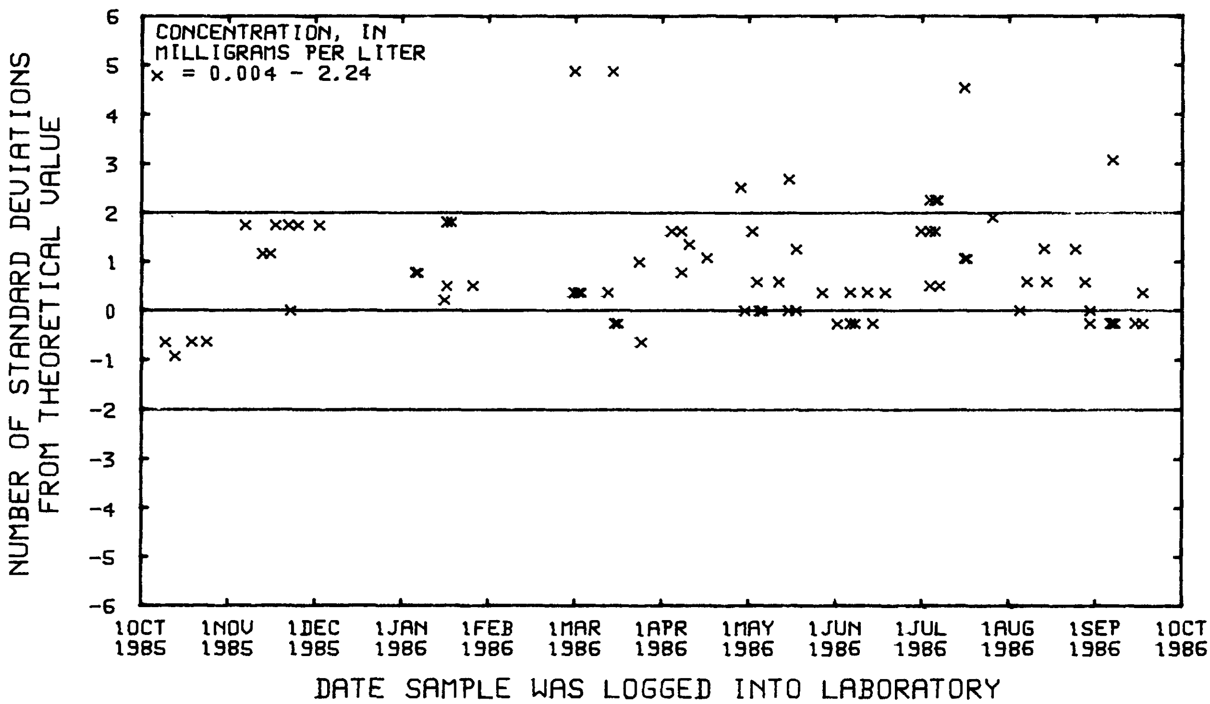


Figure 114.--Nitrite nitrogen as N, dissolved, data from the Denver laboratory.

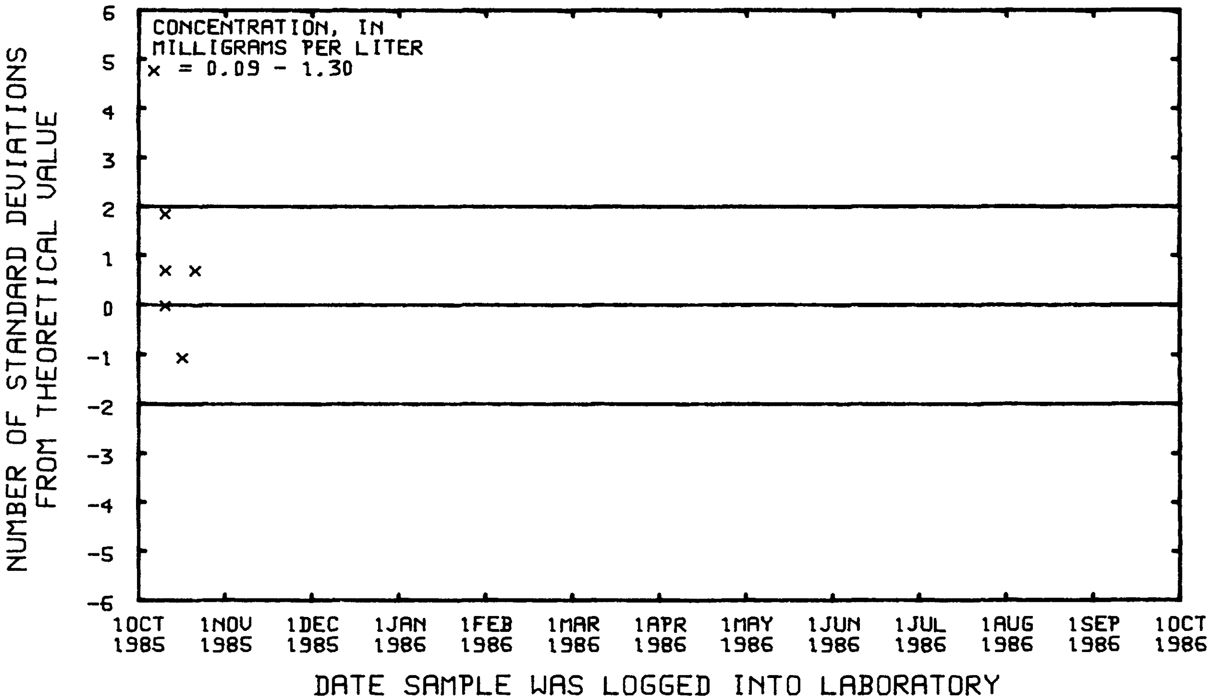


Figure 115.--Orthophosphate phosphorus as P, dissolved, data from the Atlanta laboratory.

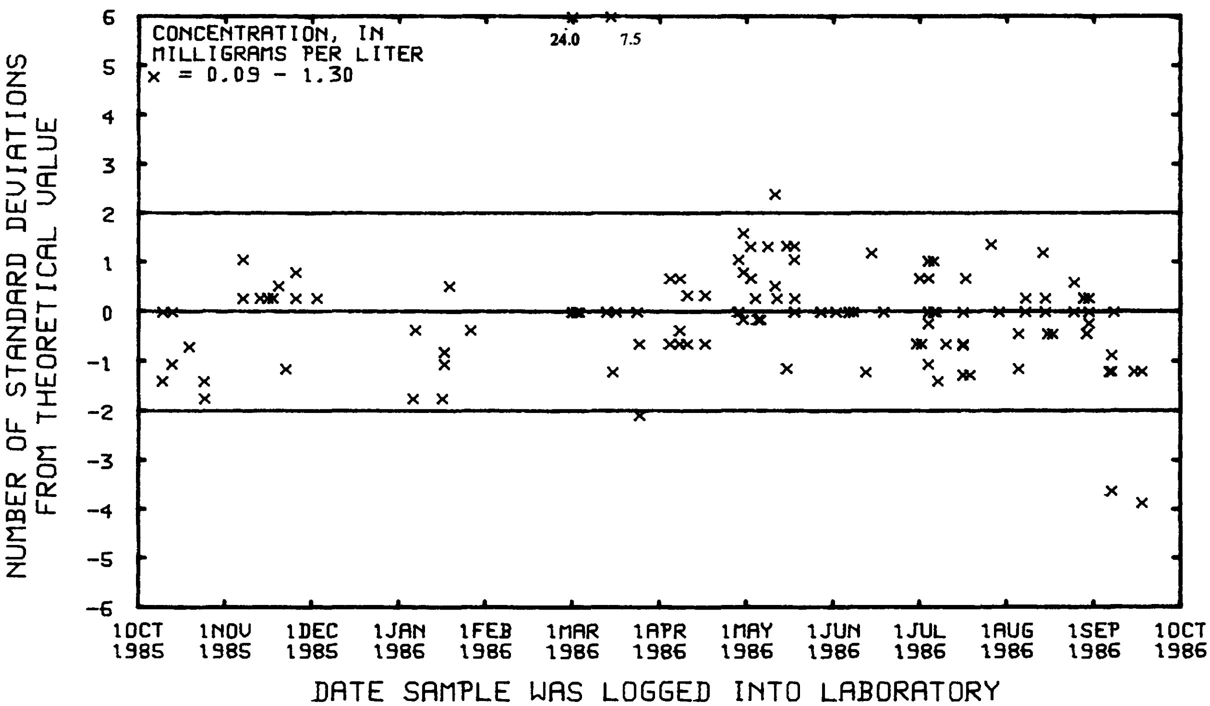


Figure 116.--Orthophosphate phosphorus as P, dissolved, data from the Denver laboratory.

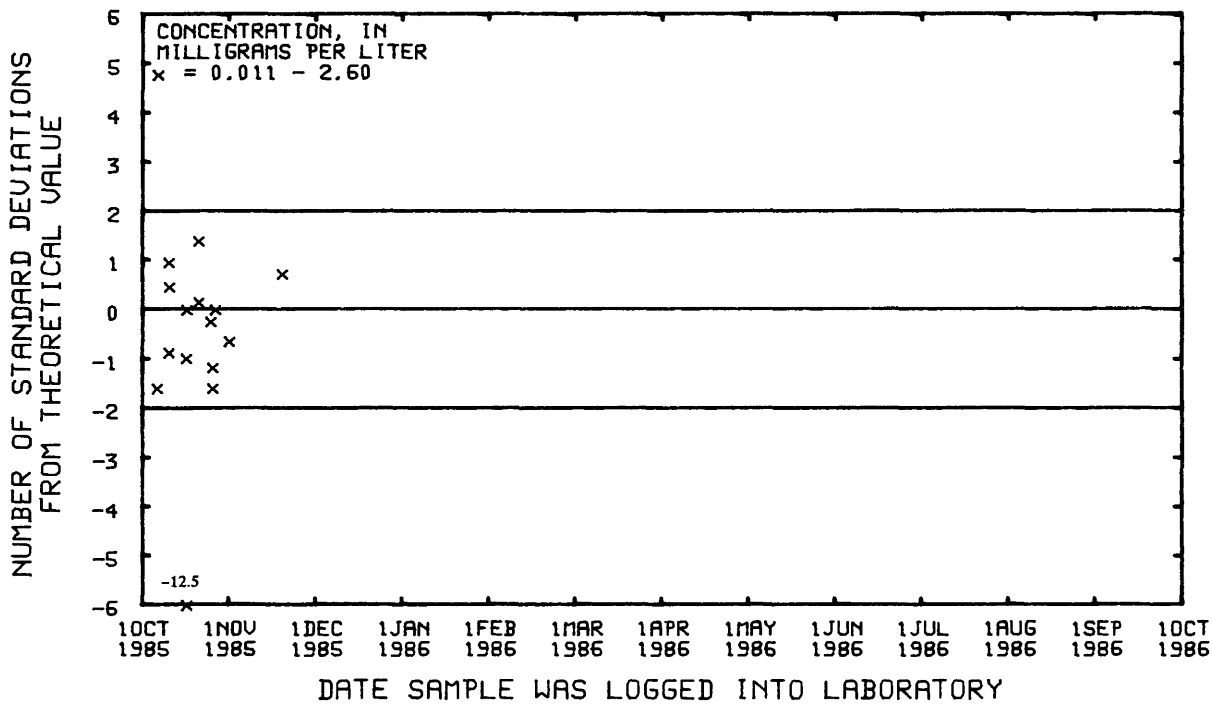


Figure 117.--Phosphorus as P, dissolved, data from the Atlanta laboratory.

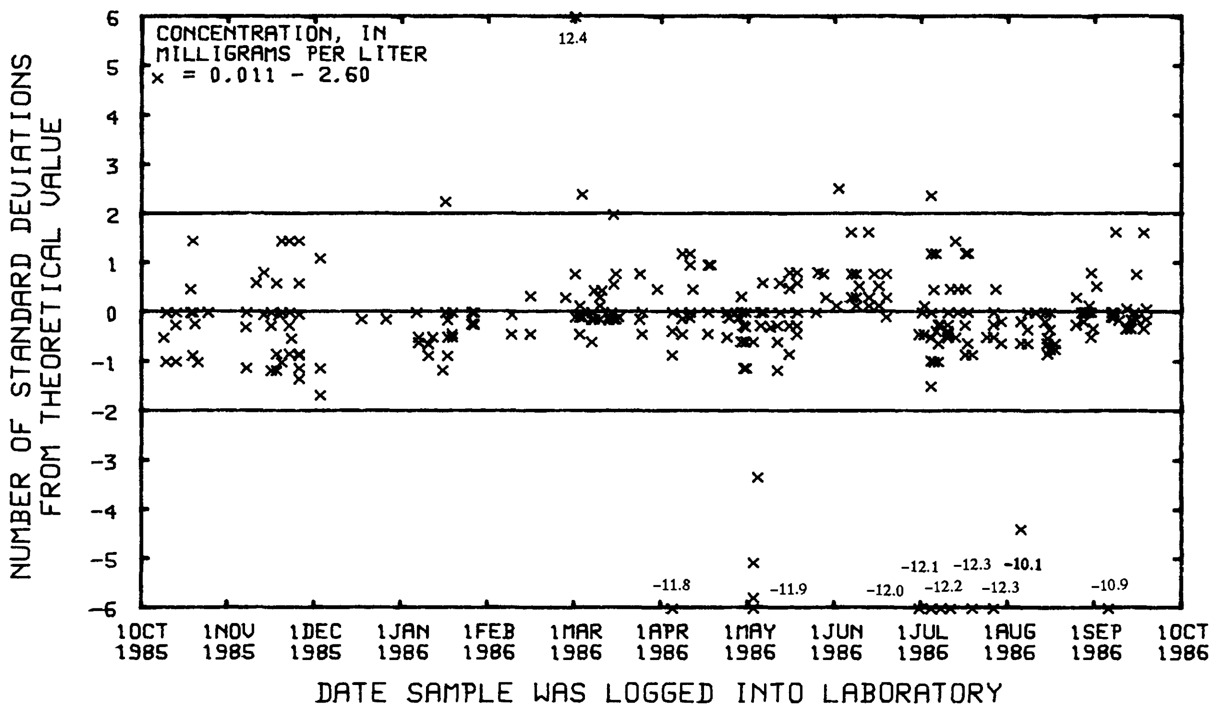


Figure 118.--Phosphorus as P, dissolved, data from the Denver laboratory.

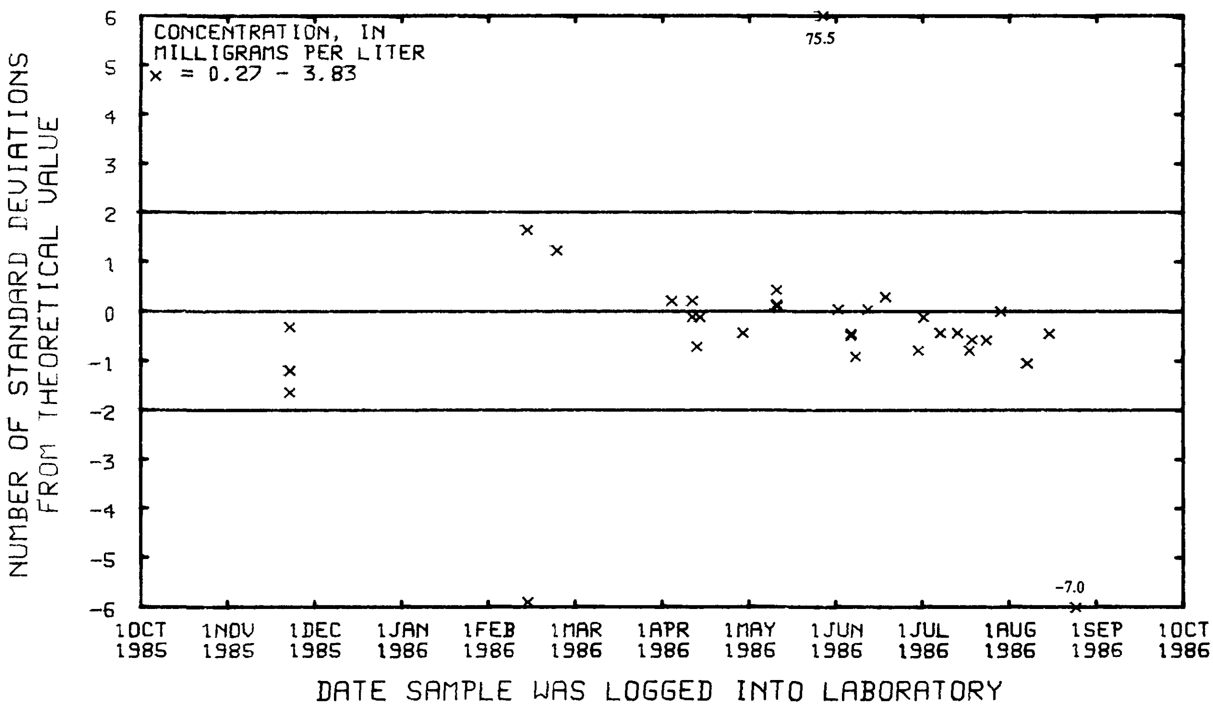


Figure 119.--Calcium, dissolved, (precipitation) data from the Denver laboratory.

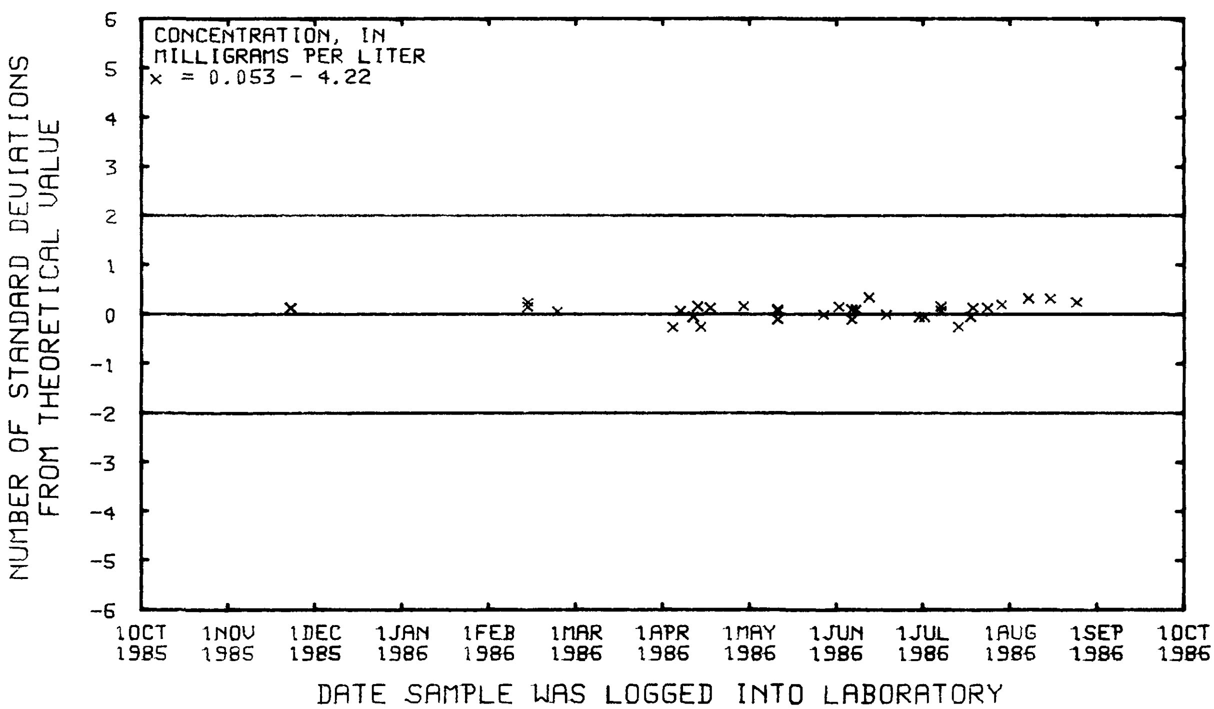


Figure 120.--Chloride, dissolved, (precipitation) data from the Denver laboratory.

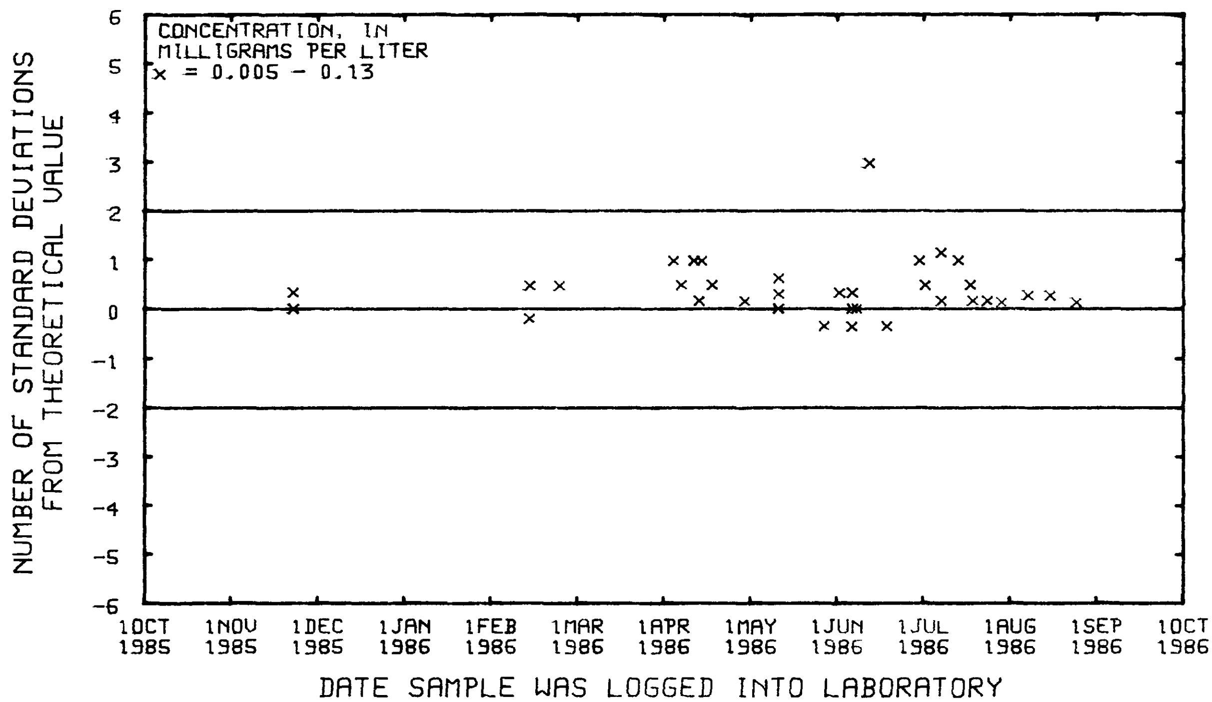


Figure 121.--Fluoride, dissolved, (precipitation) data from the Denver laboratory.

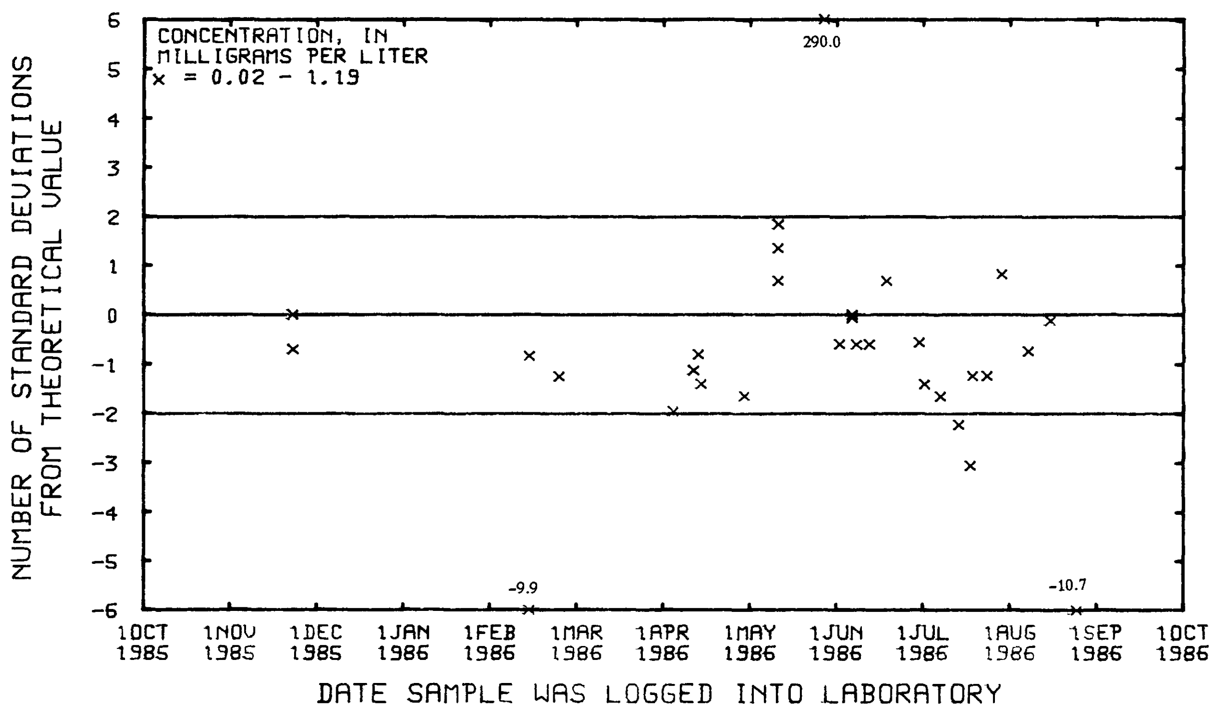


Figure 122.--Magnesium, dissolved, (precipitation) data from the Denver laboratory.

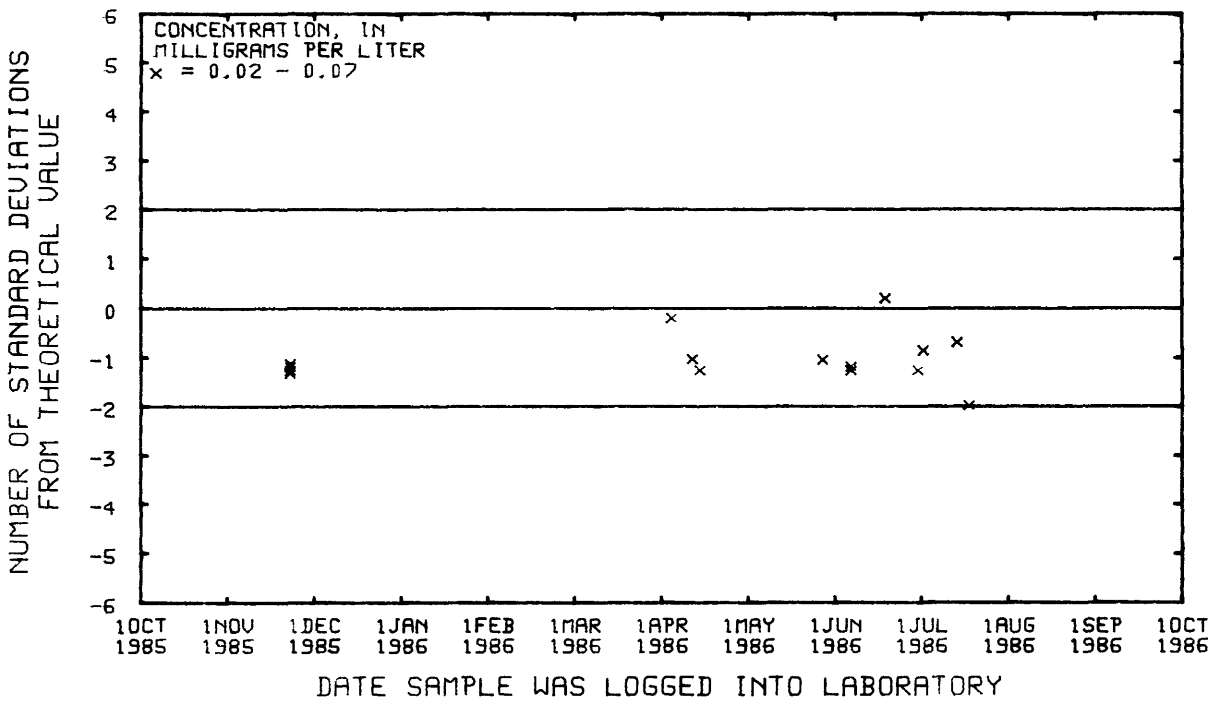


Figure 123.--Ammonia nitrogen as N, dissolved, (precipitation) data from the Denver laboratory.

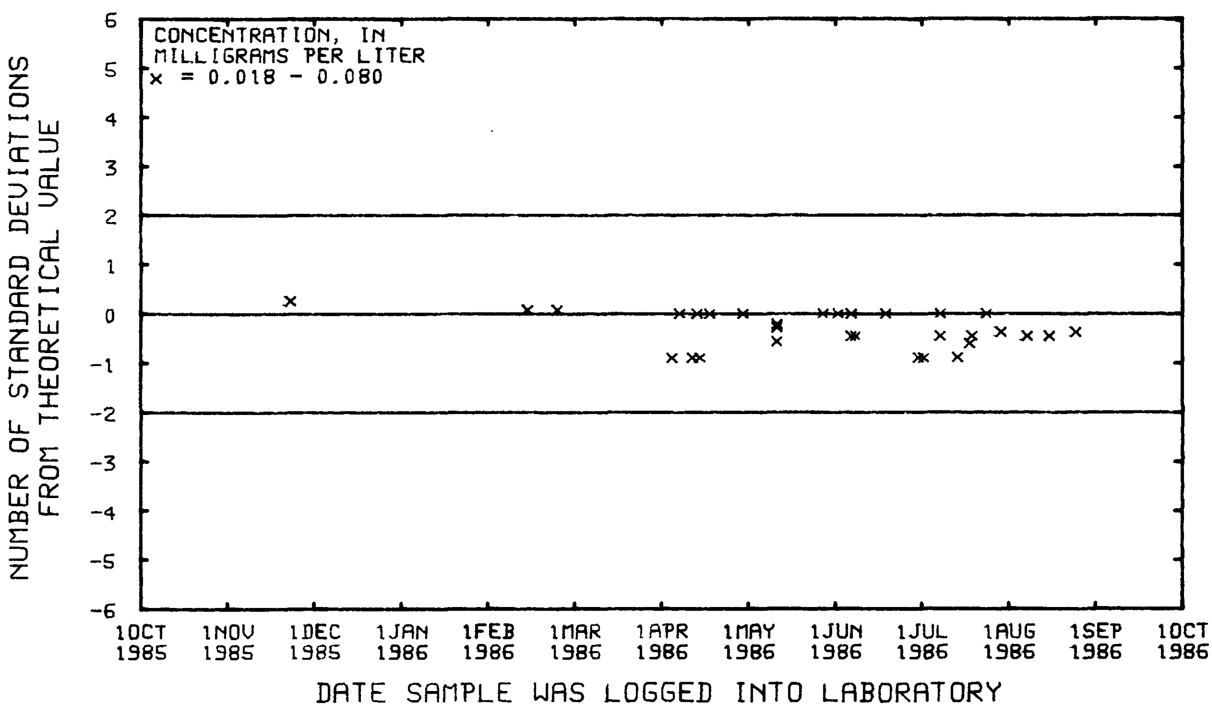


Figure 124.--Nitrate nitrogen as N, dissolved, (precipitation) data from the Denver laboratory.

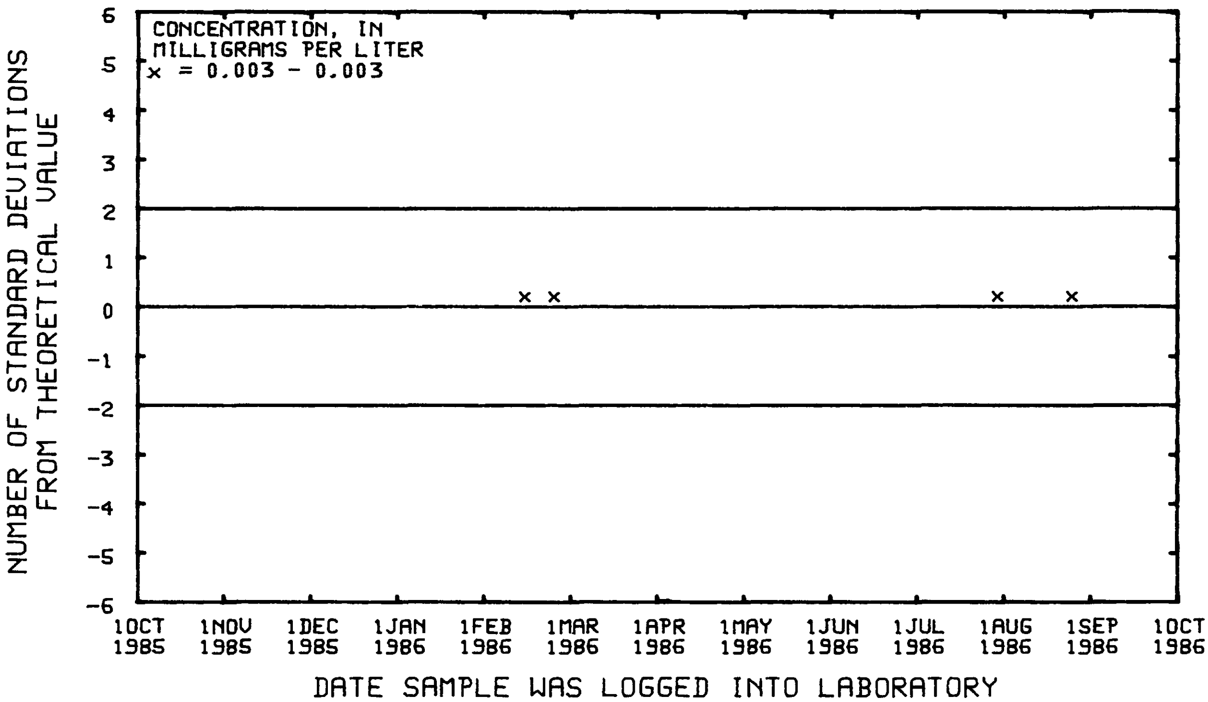


Figure 125.--Phosphorus as P, dissolved, (precipitation), data from the Denver laboratory.

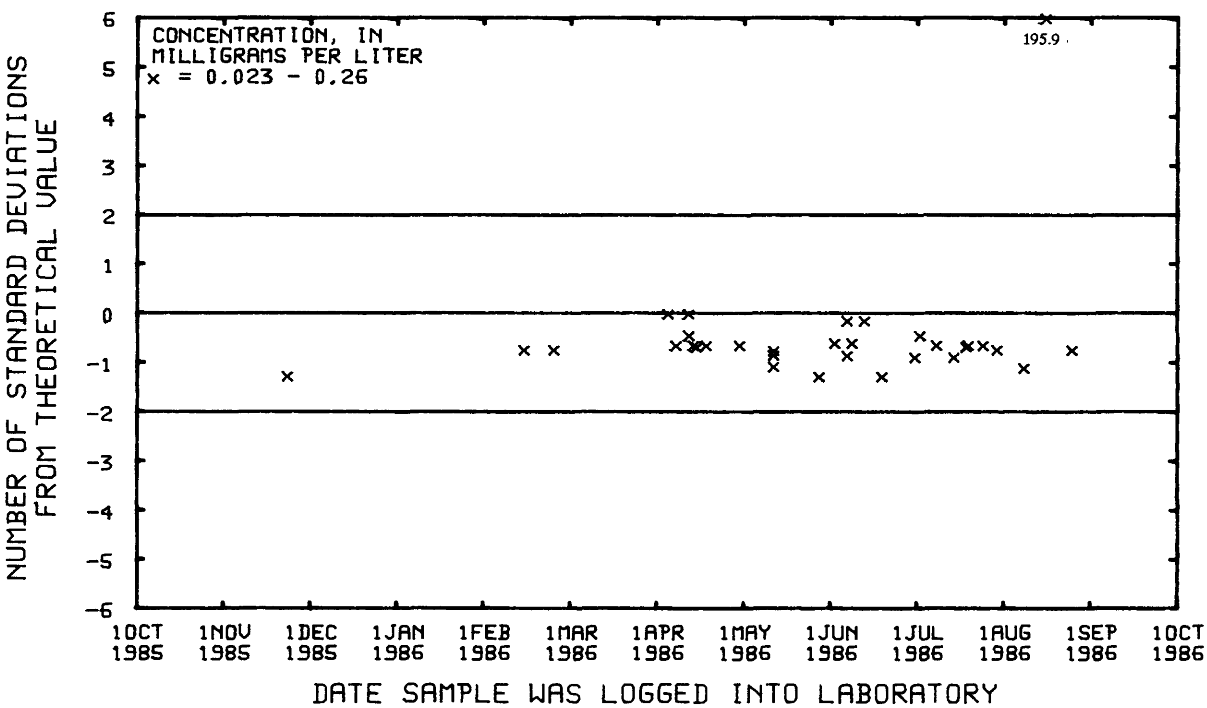


Figure 126.--Potassium, dissolved, (precipitation), data from the Denver laboratory.

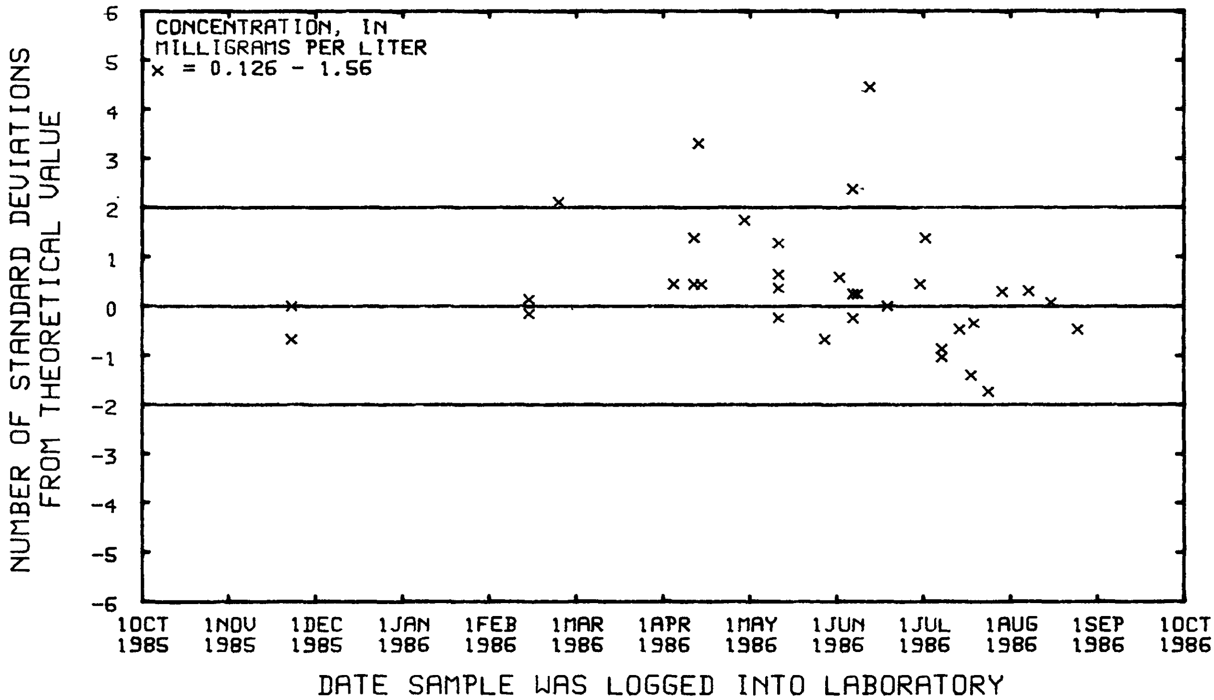


Figure 127.--Sodium, dissolved, (precipitation) data from the Denver laboratory.

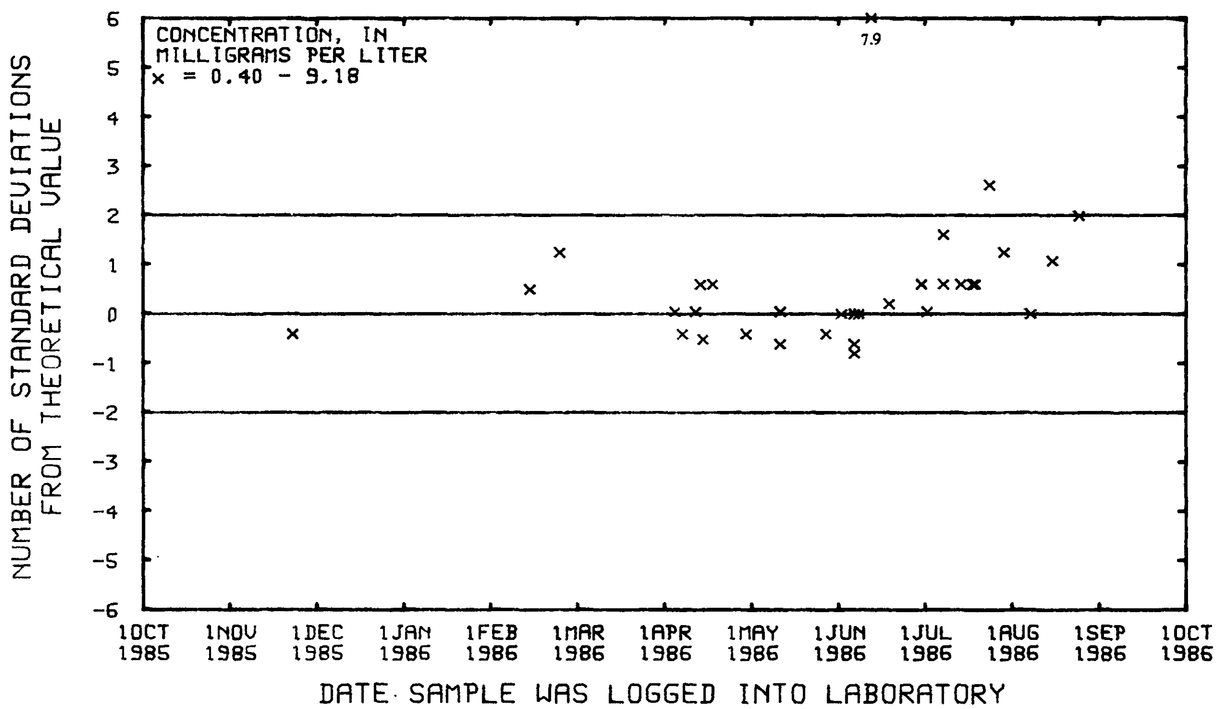


Figure 128.--Sulfate, dissolved, (precipitation) data from the Denver laboratory.

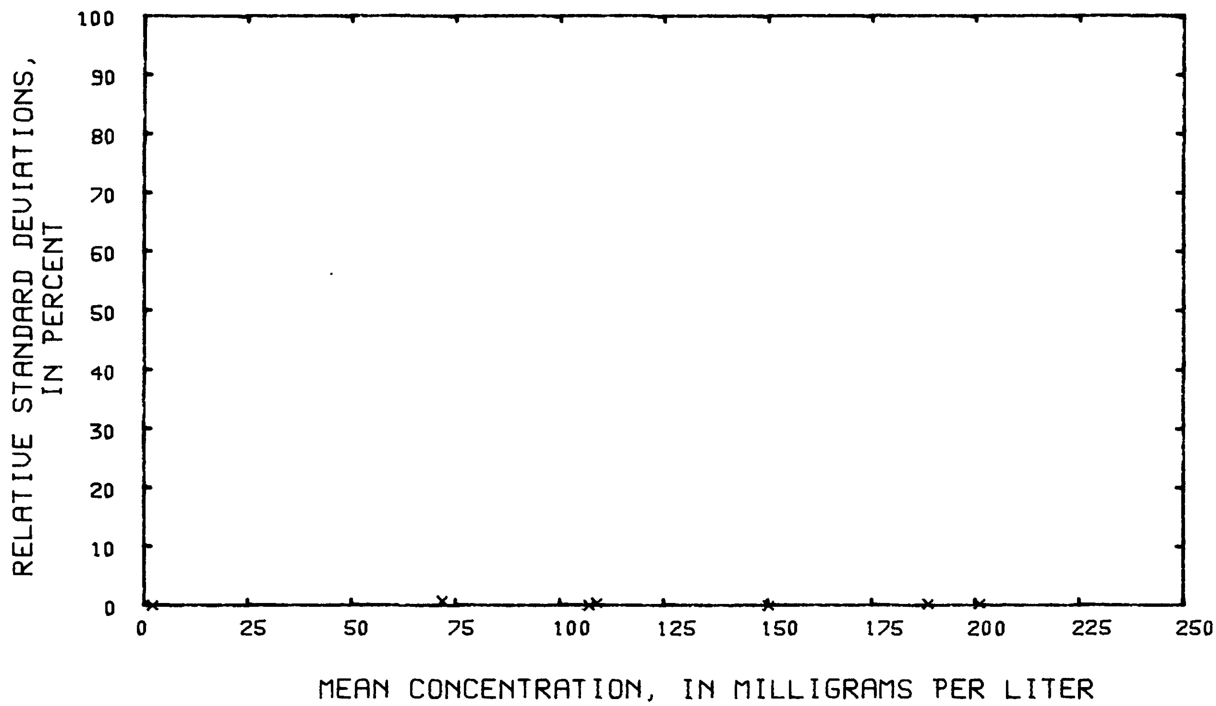


Figure 129.--Precision data for alkalinity, dissolved, at the Atlanta laboratory.

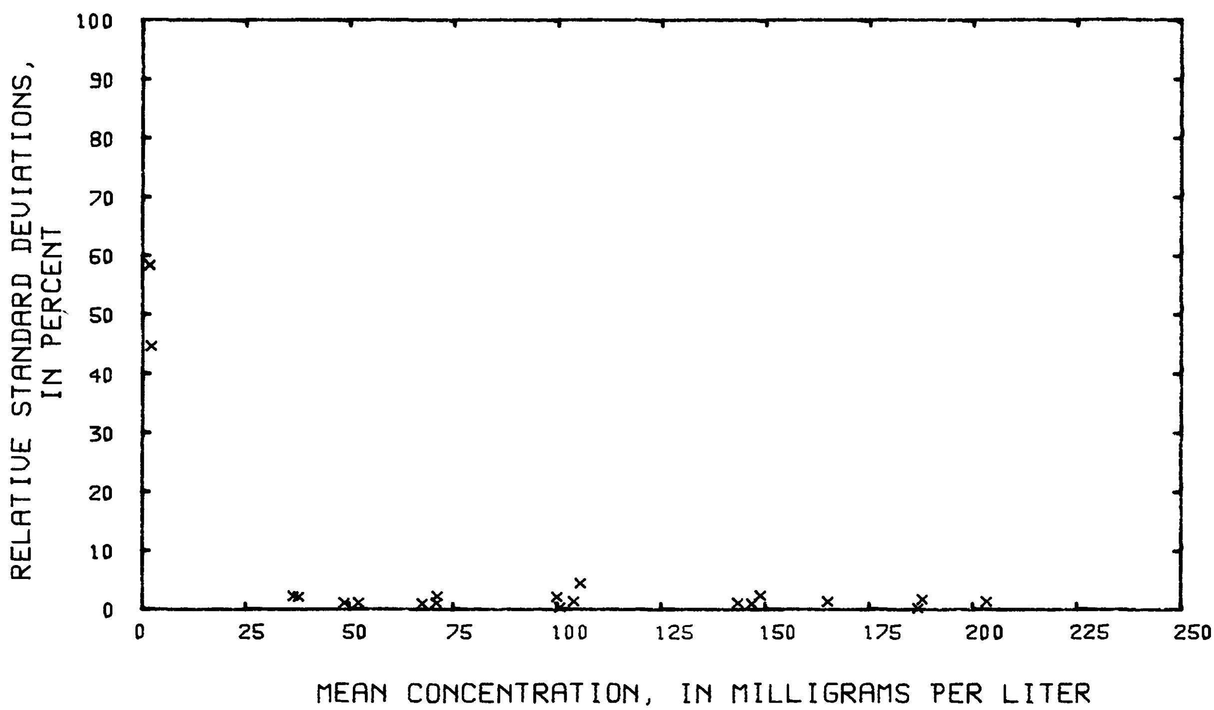


Figure 130.--Precision data for alkalinity, dissolved, at the Denver laboratory.

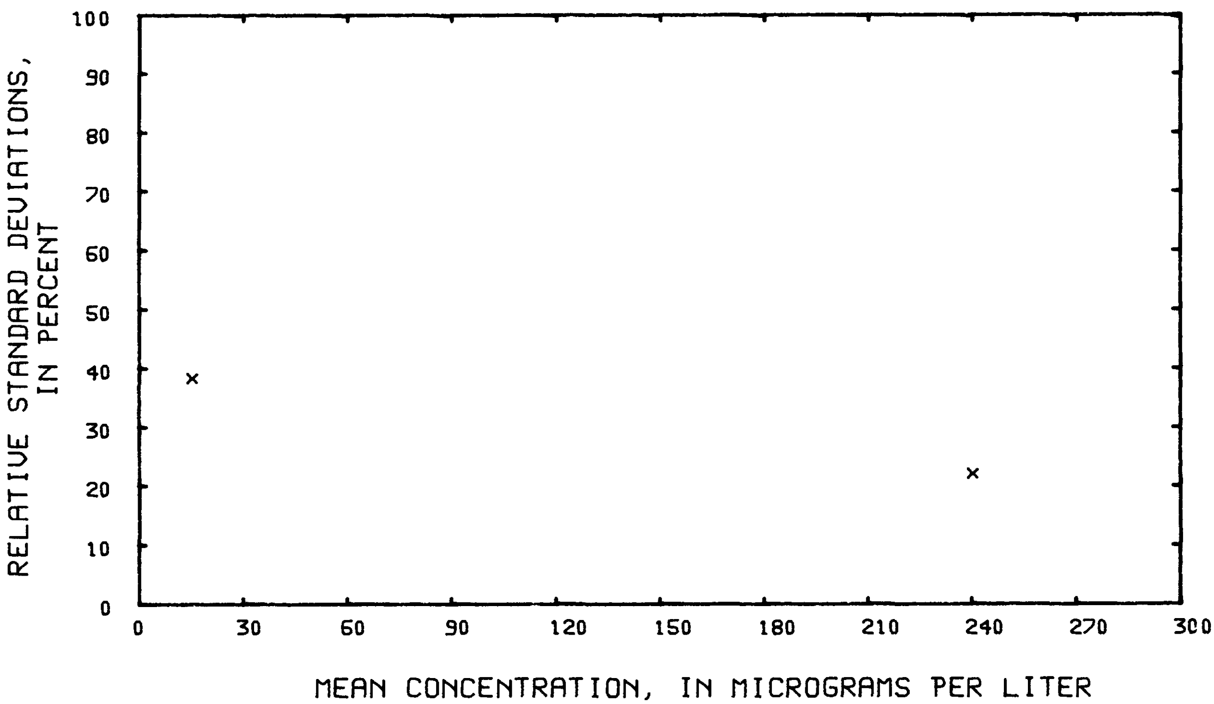


Figure 131.--Precision data for aluminum, dissolved, at the Atlanta laboratory.

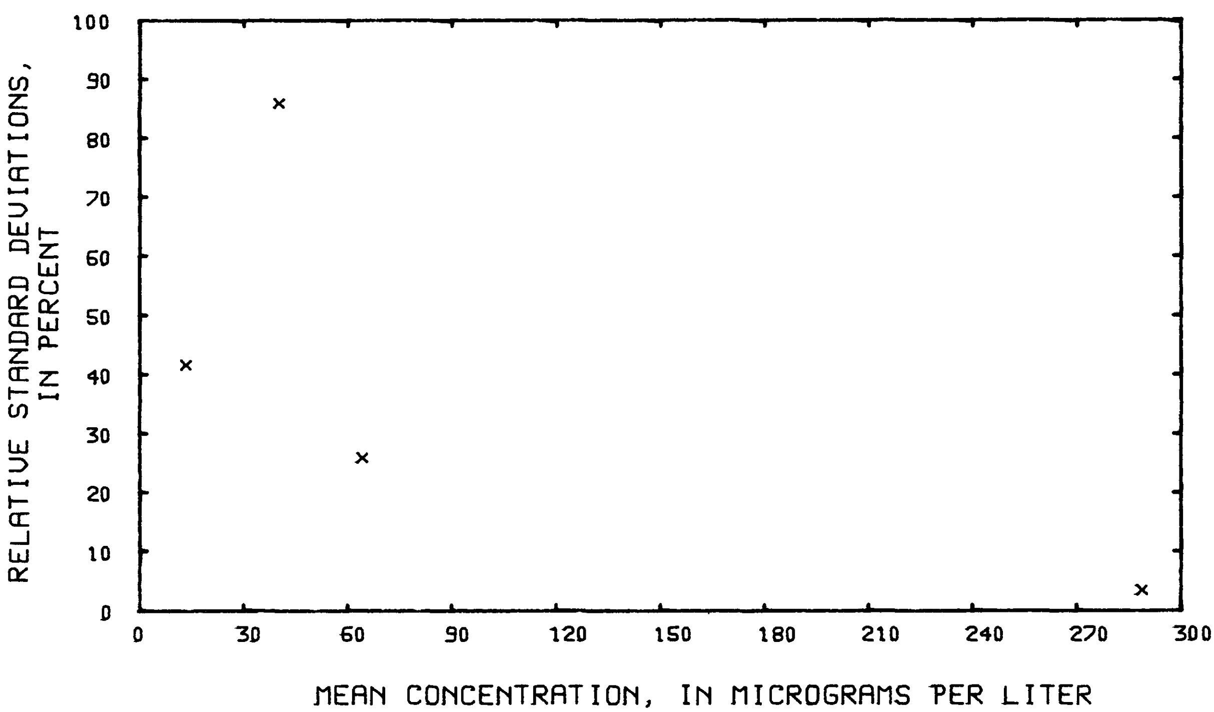


Figure 132.--Precision data for aluminum, dissolved, at the Denver laboratory.

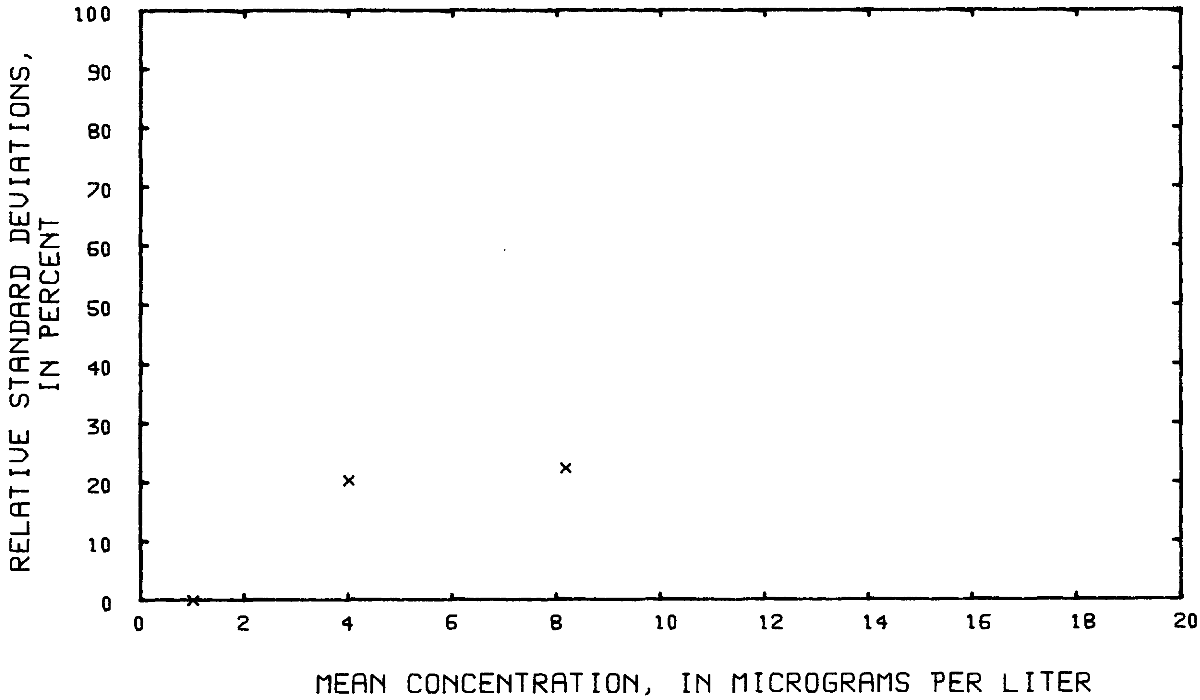


Figure 133.--Precision data for arsenic, dissolved, at the Atlanta laboratory.

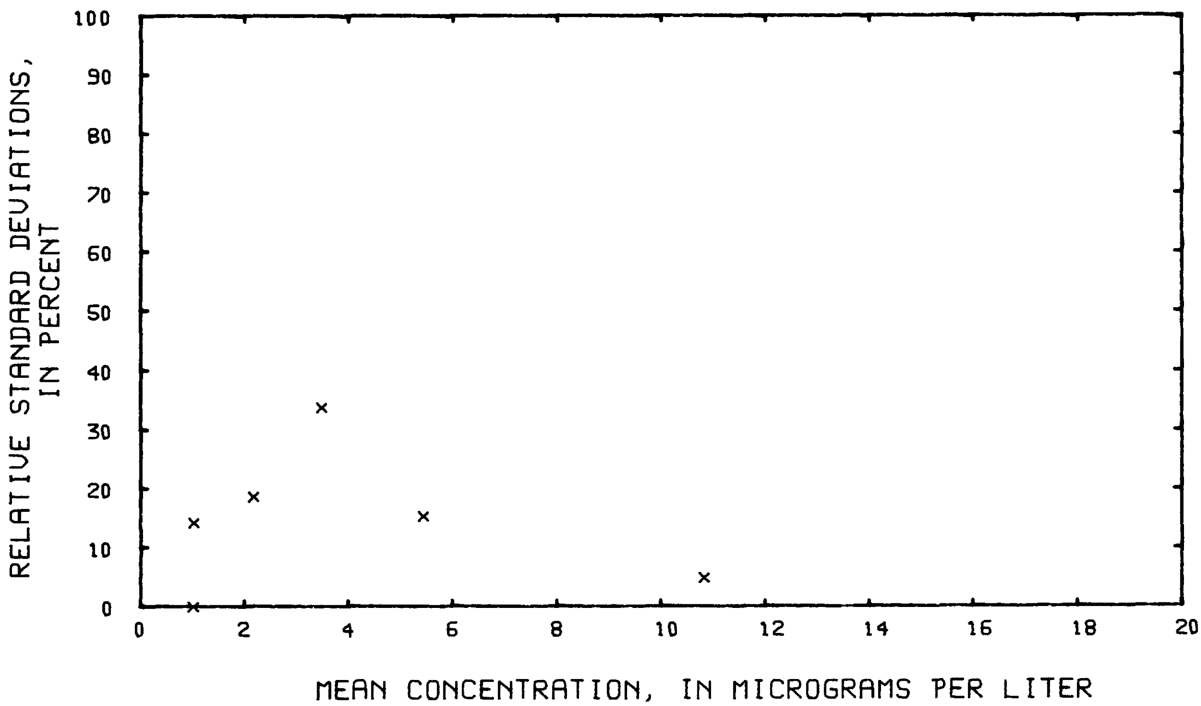


Figure 134.--Precision data for arsenic, dissolved, at the Denver laboratory.

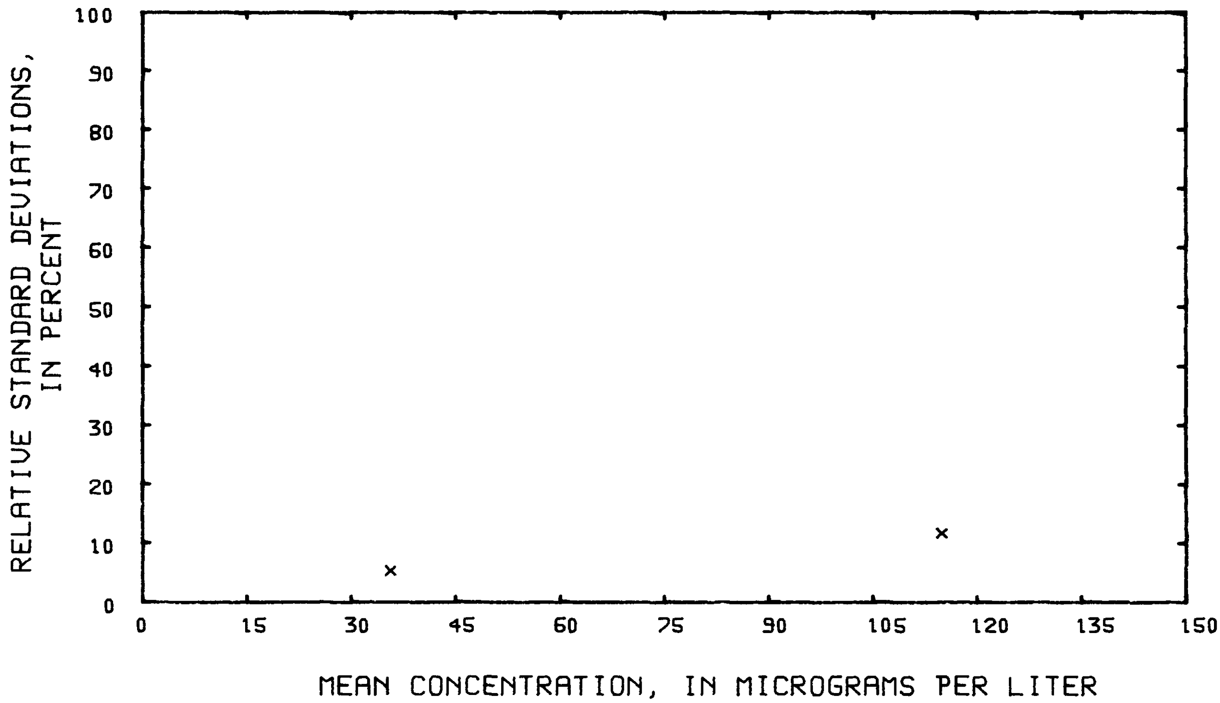


Figure 135.--Precision data for barium, dissolved, (inductively coupled plasma emission spectrometry) at the Atlanta laboratory.

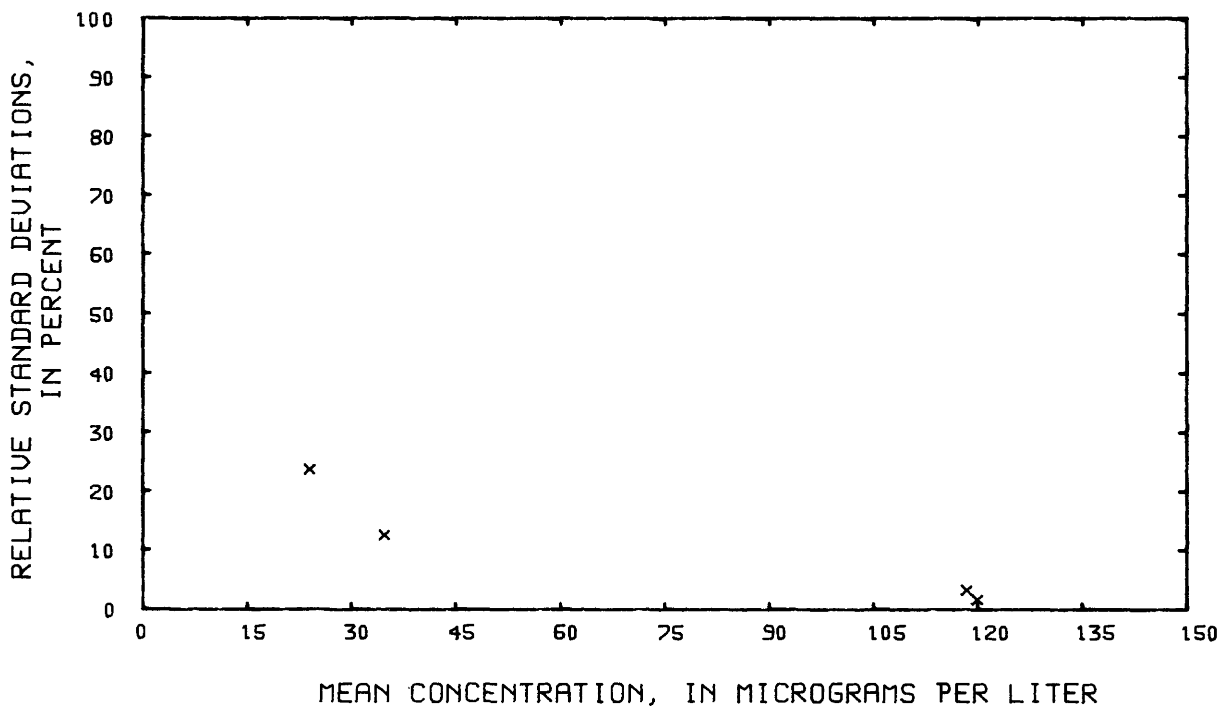


Figure 136.--Precision data for barium, dissolved, (inductively coupled plasma emission spectrometry) at the Denver laboratory.

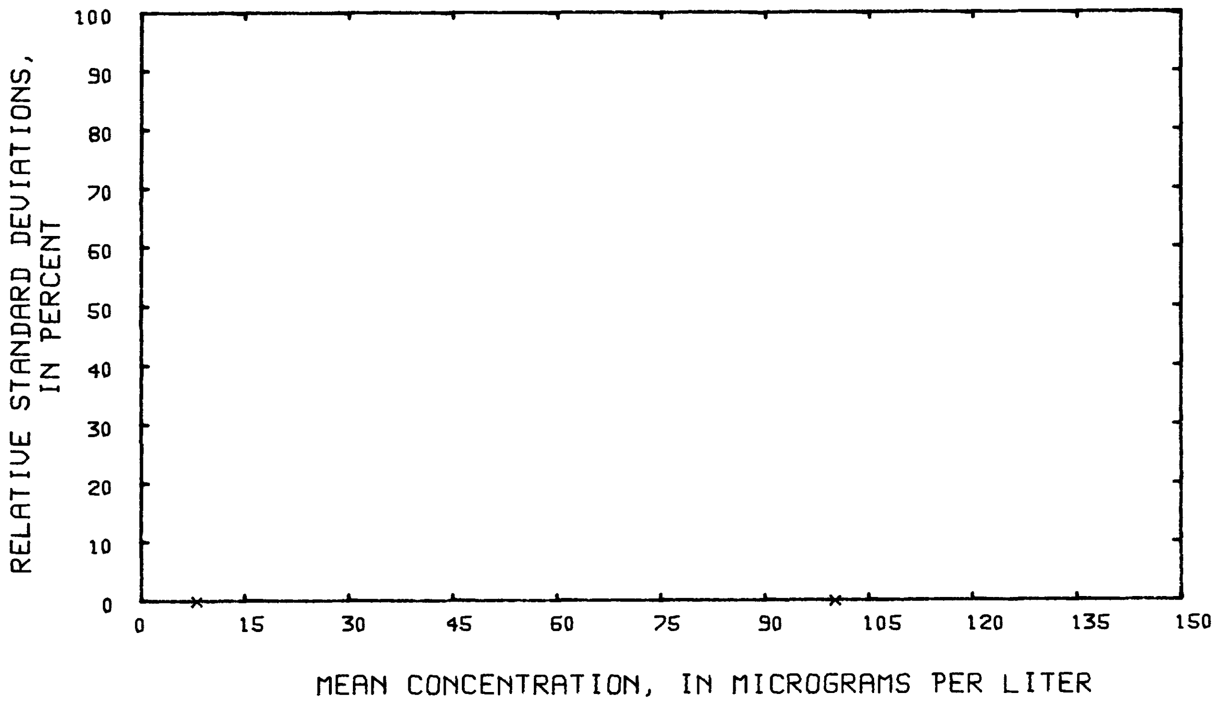


Figure 137.--Precision data for barium, dissolved, (atomic absorption spectrometry) at the Atlanta laboratory.

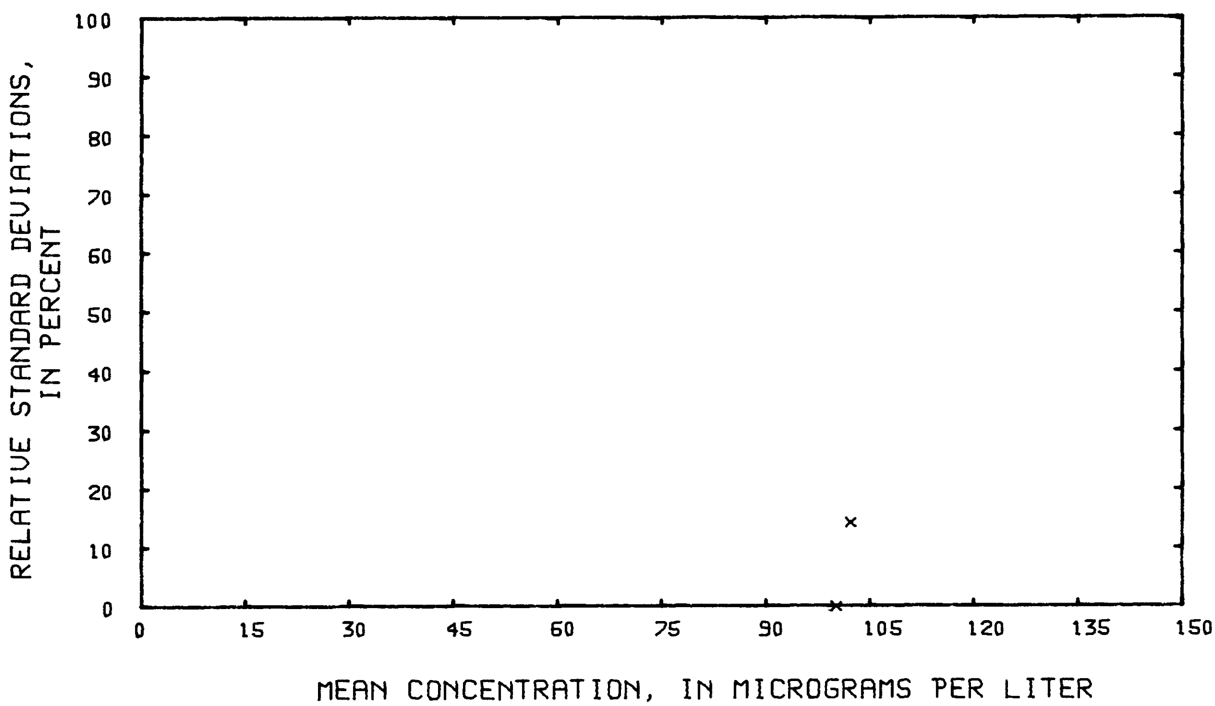


Figure 138.--Precision data for barium, dissolved, (atomic absorption spectrometry) at the Denver laboratory.

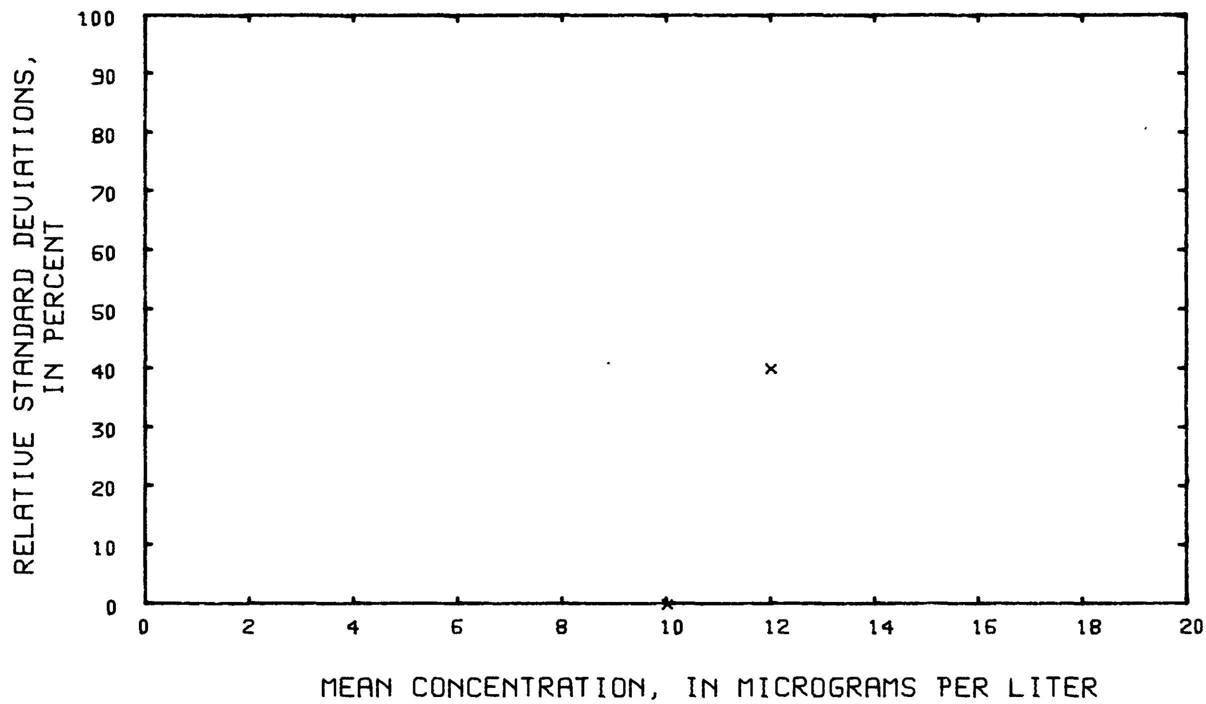


Figure 139.--Precision data for barium, total recoverable, at the Atlanta laboratory.

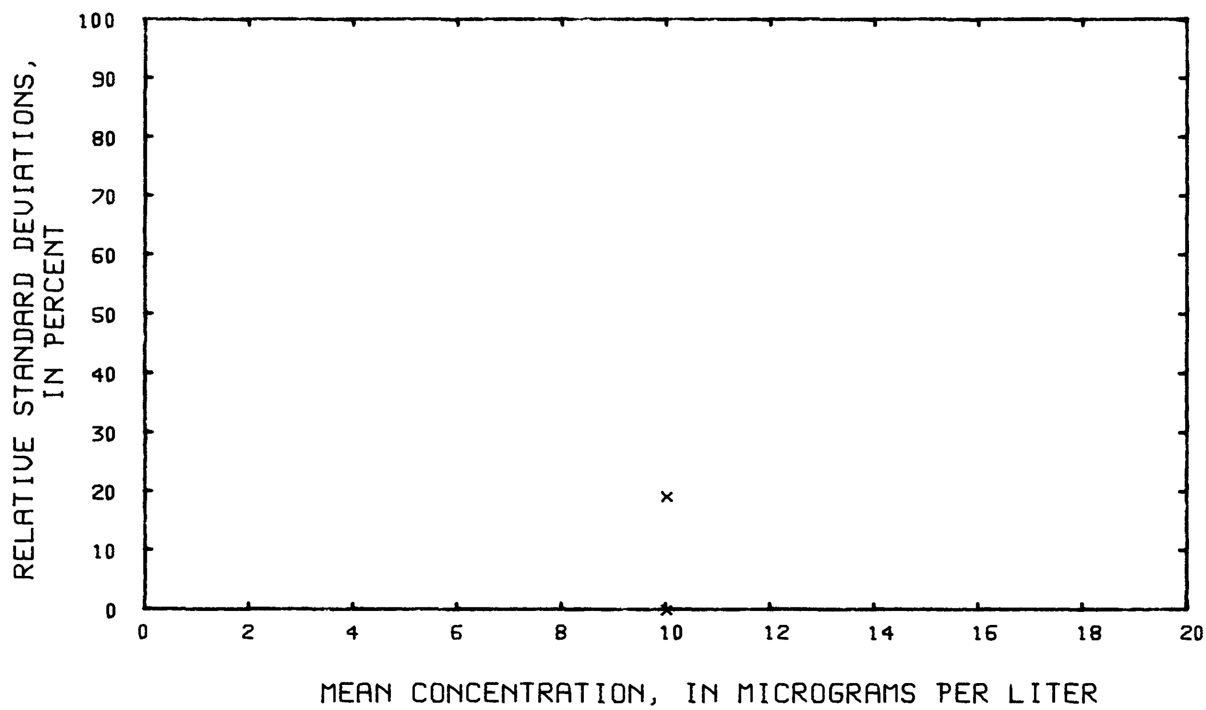


Figure 140.--Precision data for barium, total recoverable, at the Denver laboratory,

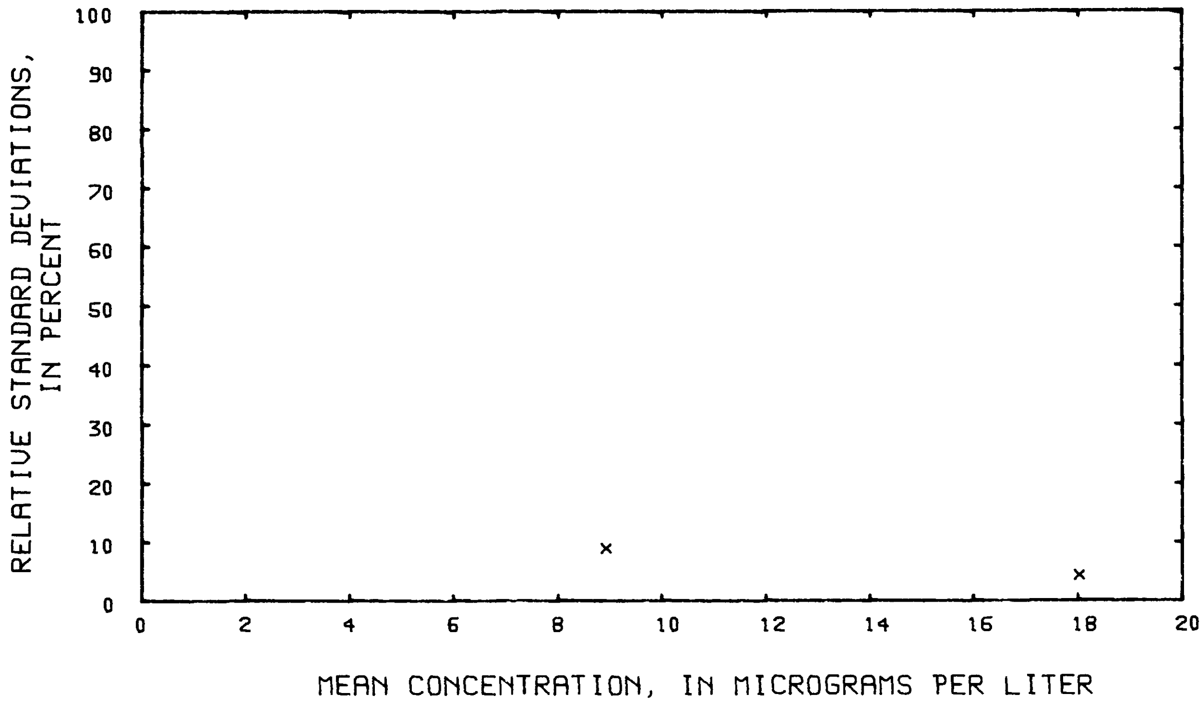


Figure 141.--Precision data for beryllium, dissolved, at the Atlanta laboratory.

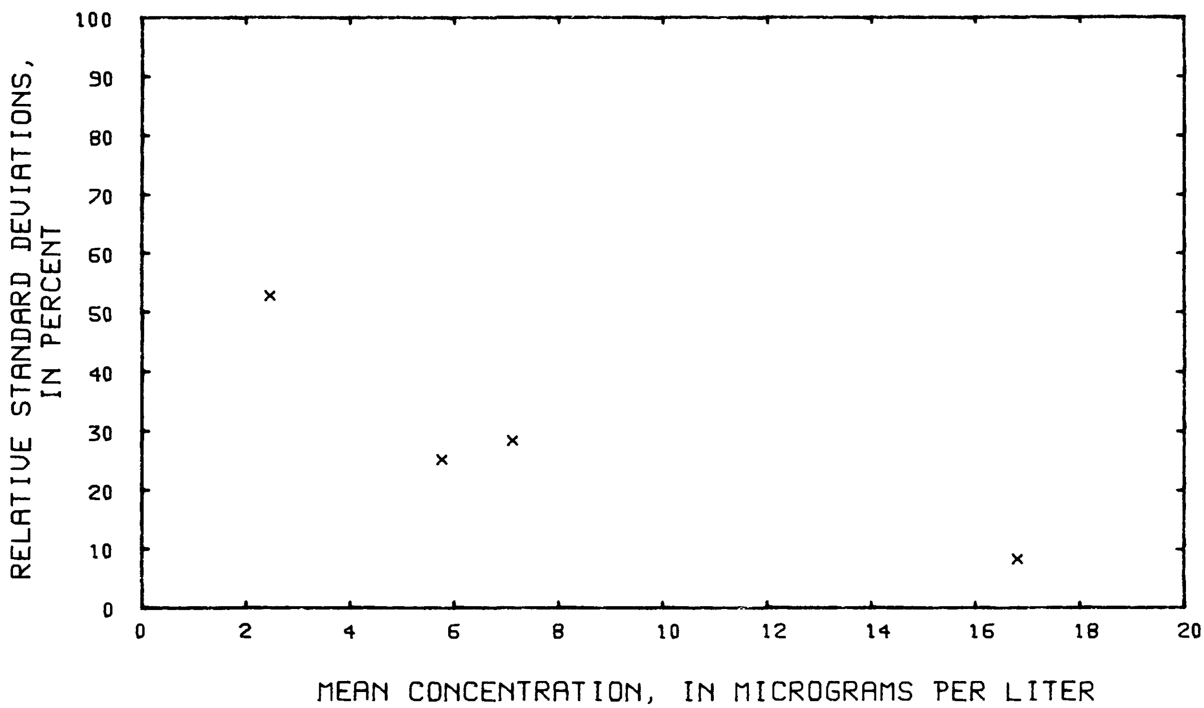


Figure 142.--Precision data for beryllium, dissolved, at the Denver laboratory.

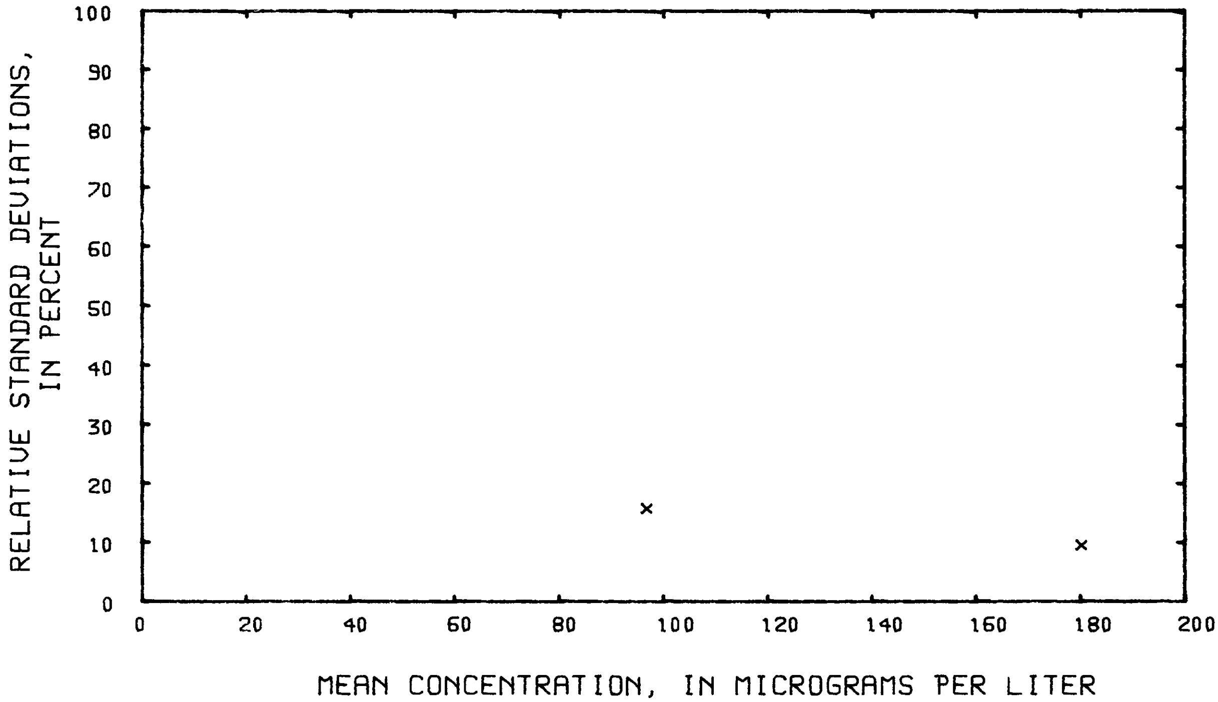


Figure 143.--Precision data for boron, dissolved, at the Atlanta laboratory.

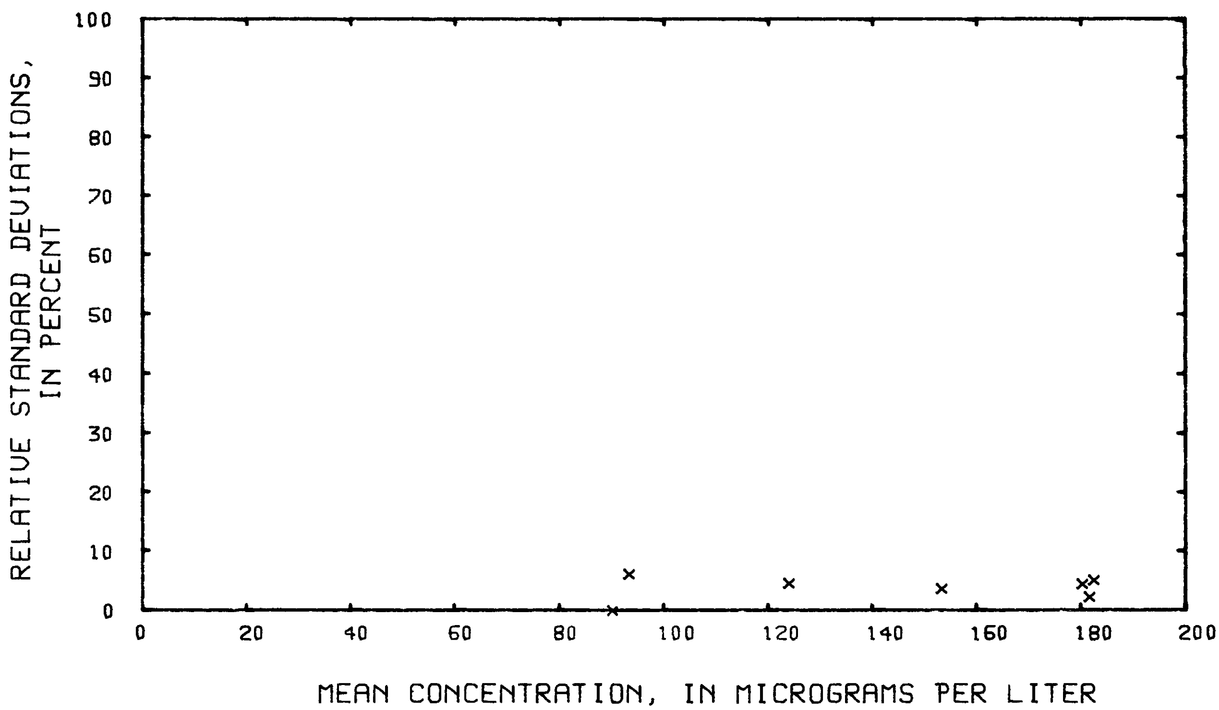


Figure 144.--Precision data for boron, dissolved, at the Denver laboratory.

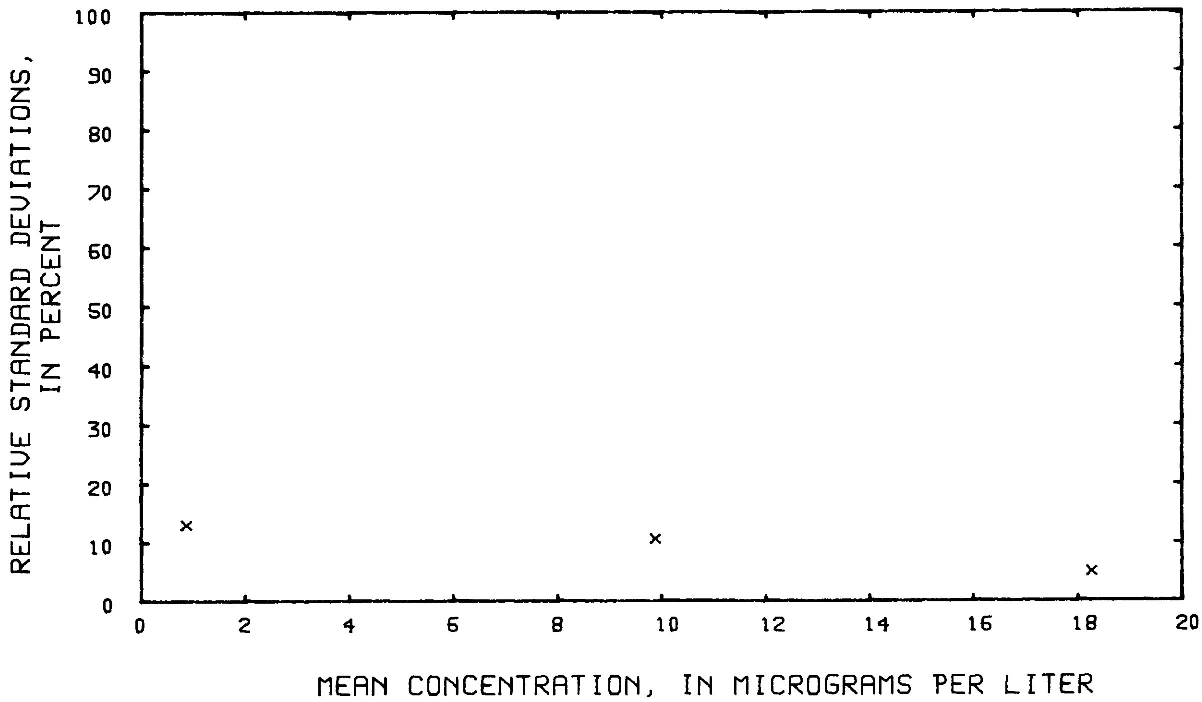


Figure 145.--Precision data for cadmium, dissolved, (inductively coupled plasma emission spectrometry) at the Atlanta laboratory.

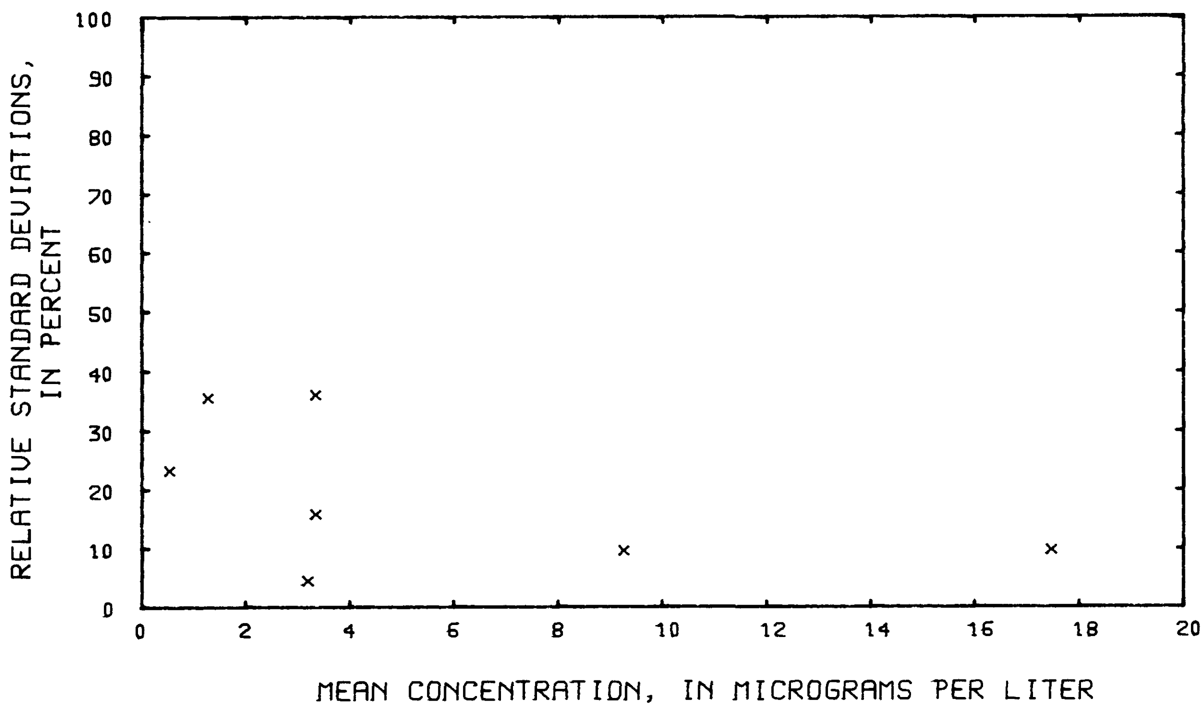


Figure 146.--Precision data for cadmium, dissolved, (inductively coupled plasma emission spectrometry) at the Denver laboratory.

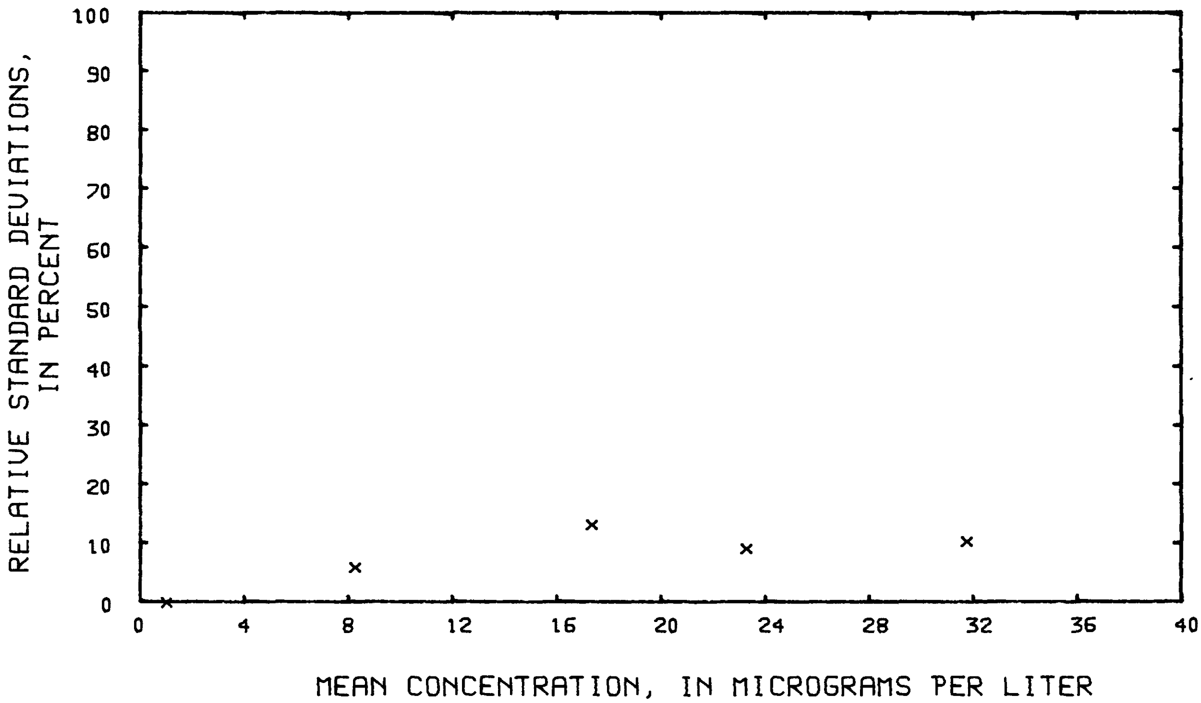


Figure 147.--Precision data for cadmium, dissolved, (atomic absorption spectrometry) at the Atlanta laboratory.

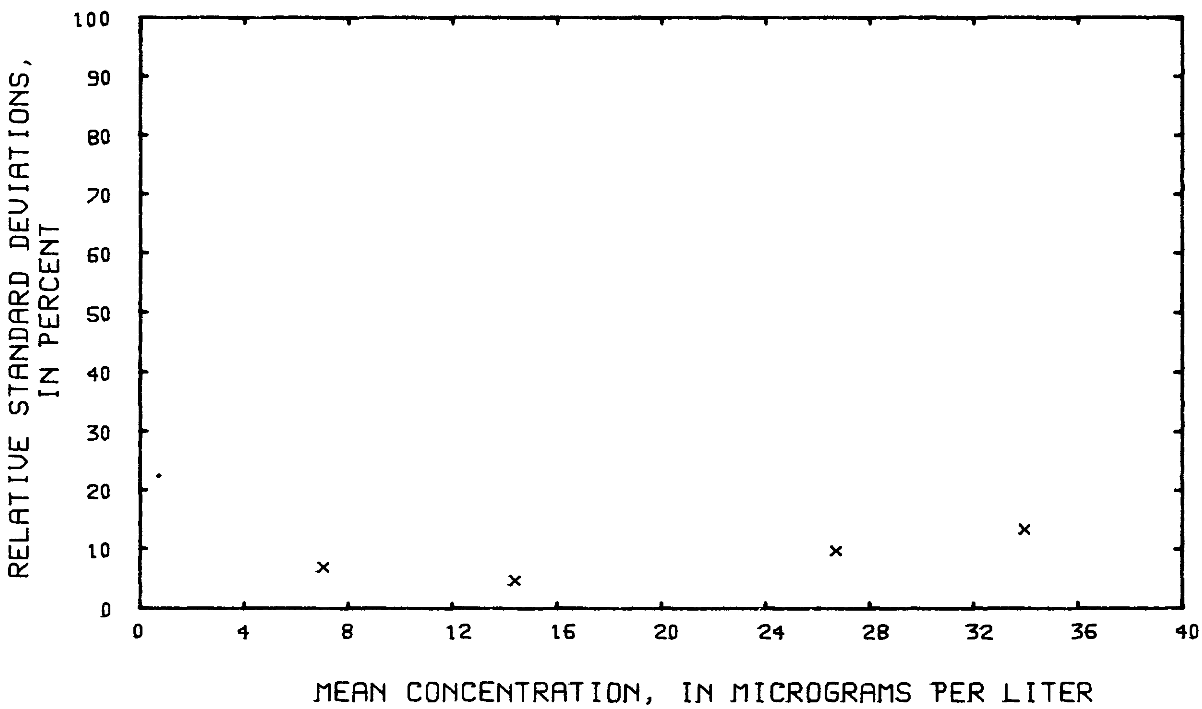


Figure 148.--Precision data for cadmium, dissolved, (atomic absorption spectrometry) at the Denver laboratory.

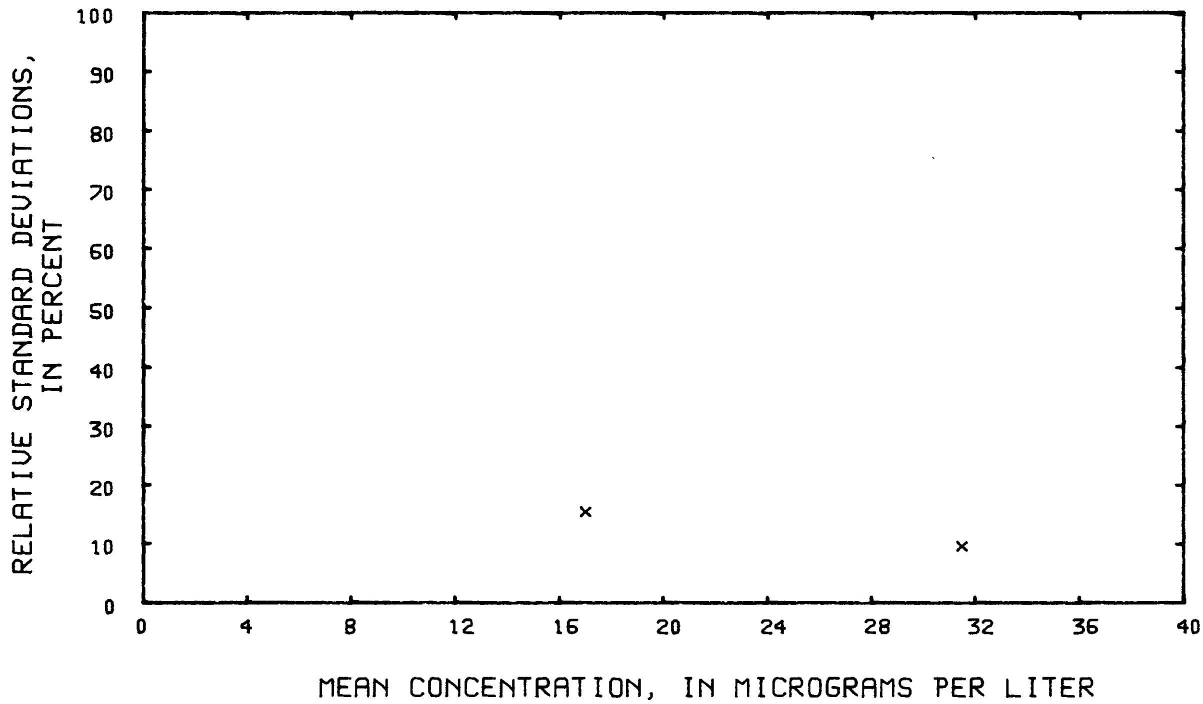


Figure 149.--Precision data for cadmium, total recoverable, at the Atlanta laboratory.

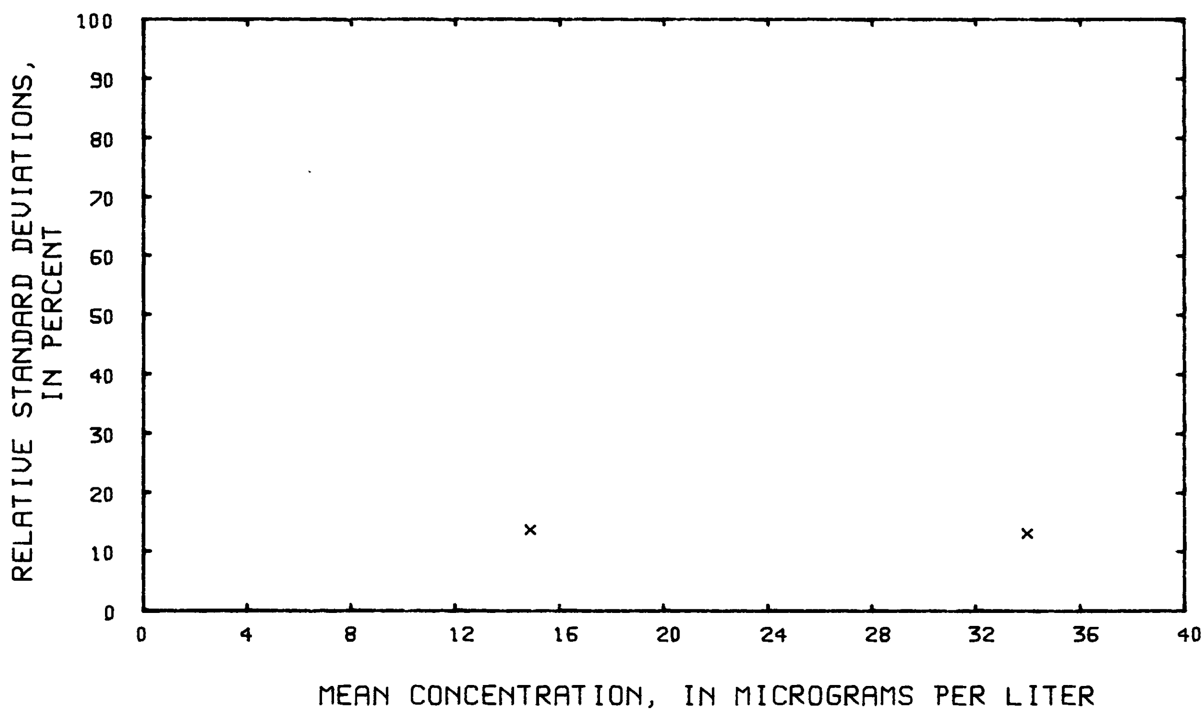


Figure 150.--Precision data for cadmium, total recoverable, at the Denver laboratory.

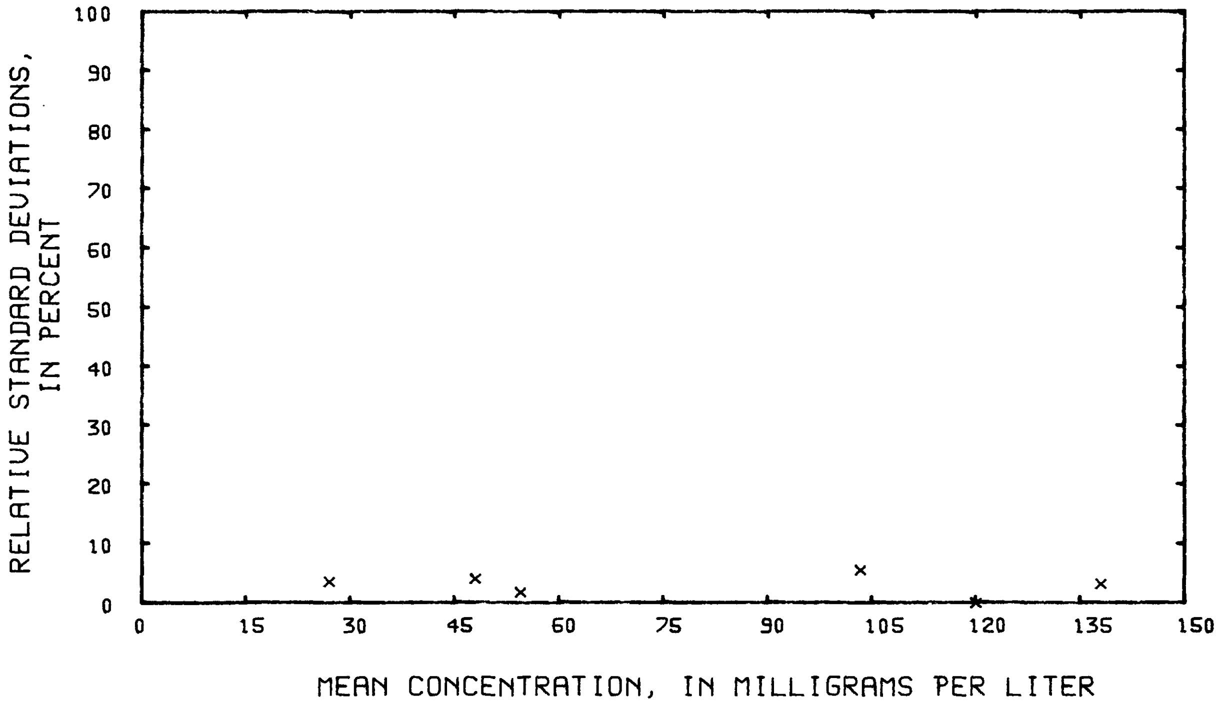


Figure 151.--Precision data for calcium, dissolved, (inductively coupled plasma emission spectrometry) at the Atlanta laboratory.

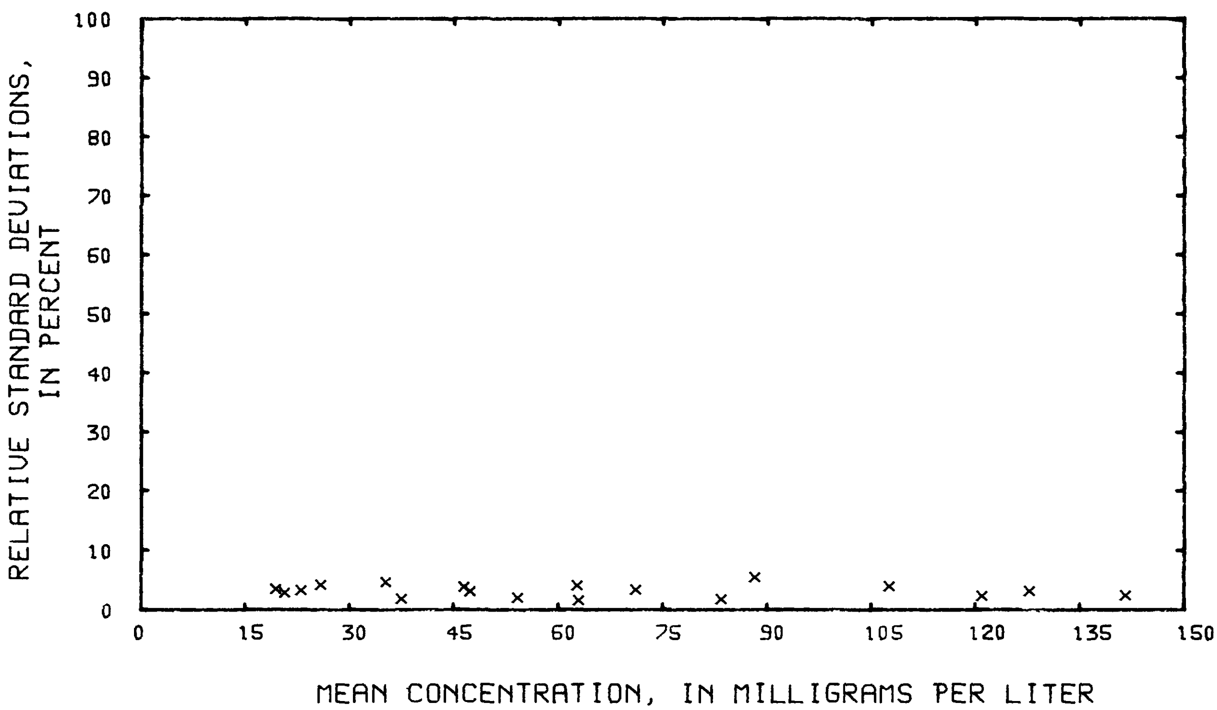


Figure 152.--Precision data for calcium, dissolved, (inductively coupled plasma emission spectrometry) at the Denver laboratory.

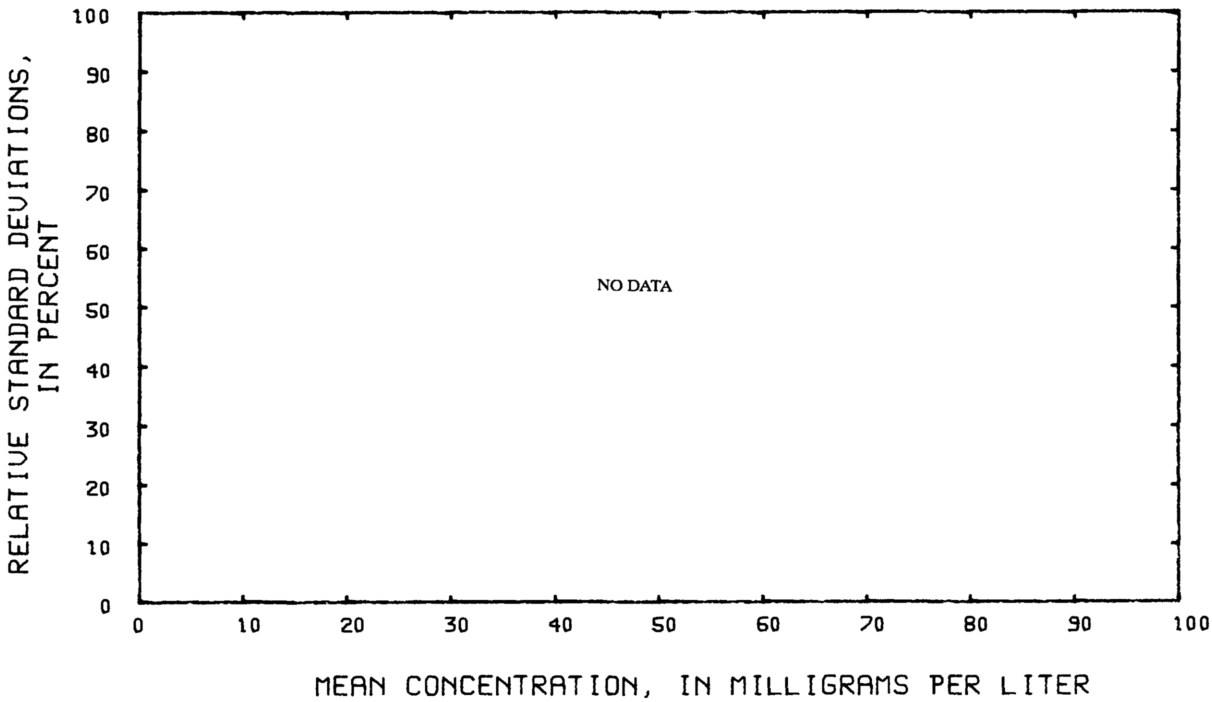


Figure 153.--Precision data for calcium, dissolved, (atomic absorption spectrometry) at the Atlanta laboratory.

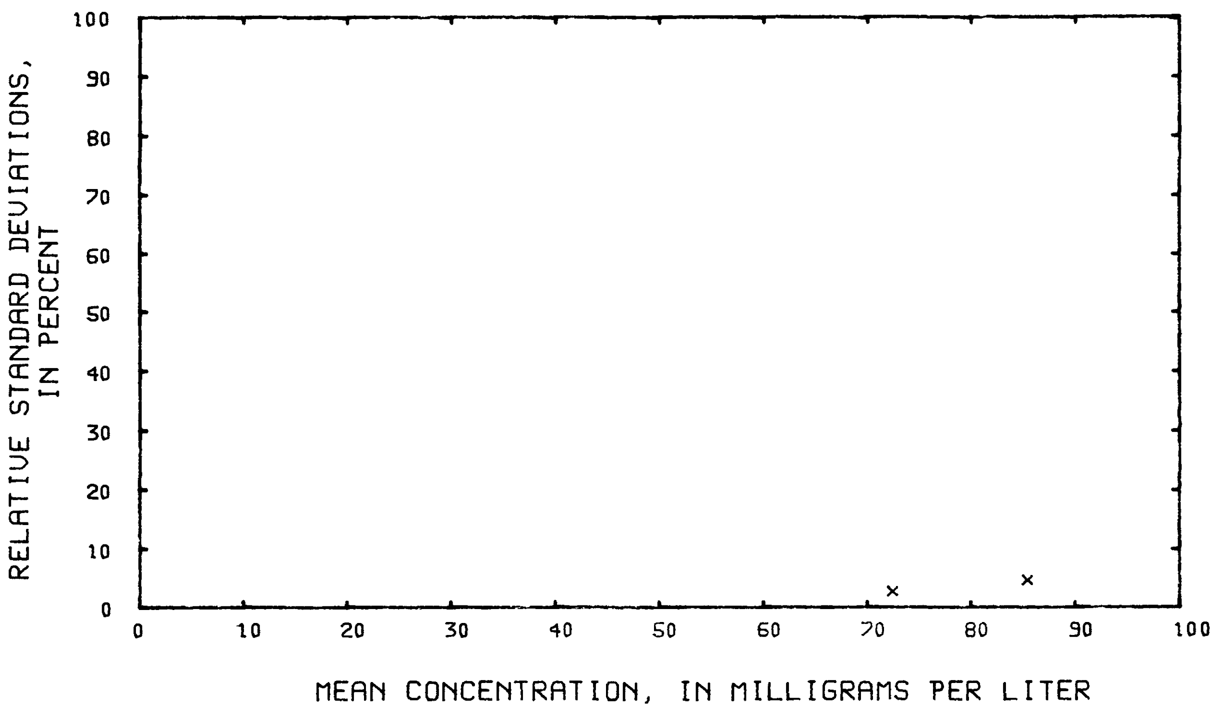


Figure 154.--Precision data for calcium, dissolved, (atomic absorption spectrometry) at the Denver laboratory.

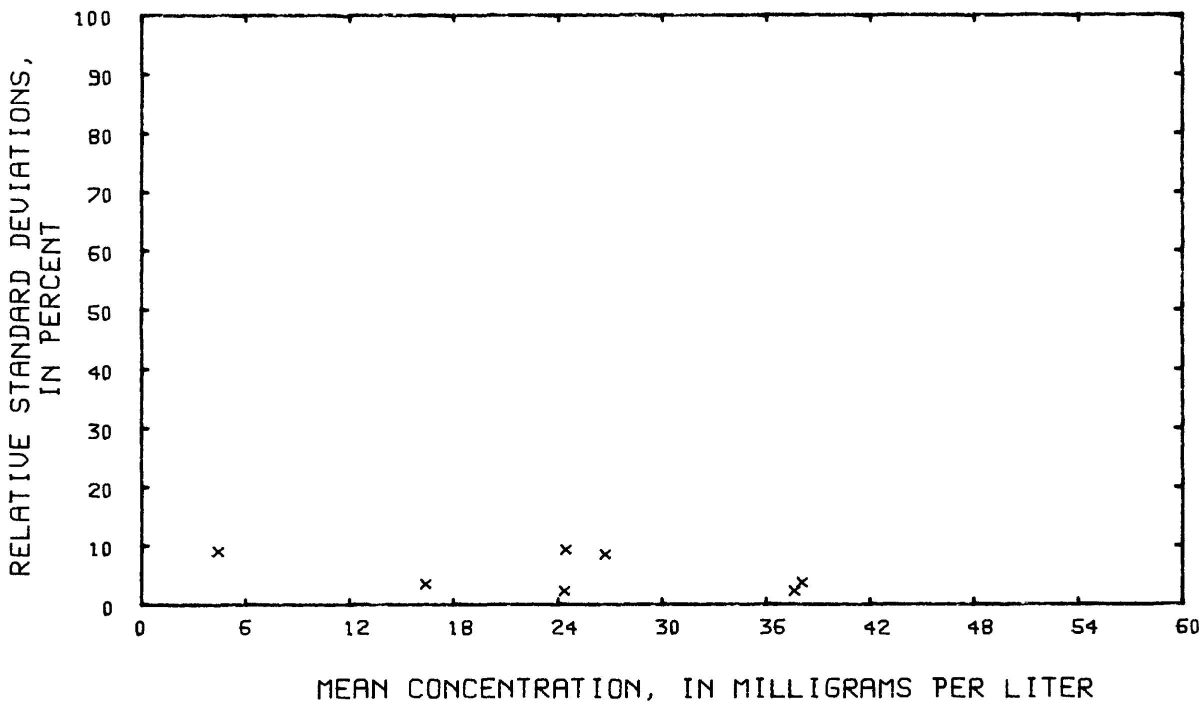


Figure 155.--Precision data for chloride, dissolved, at the Atlanta laboratory.

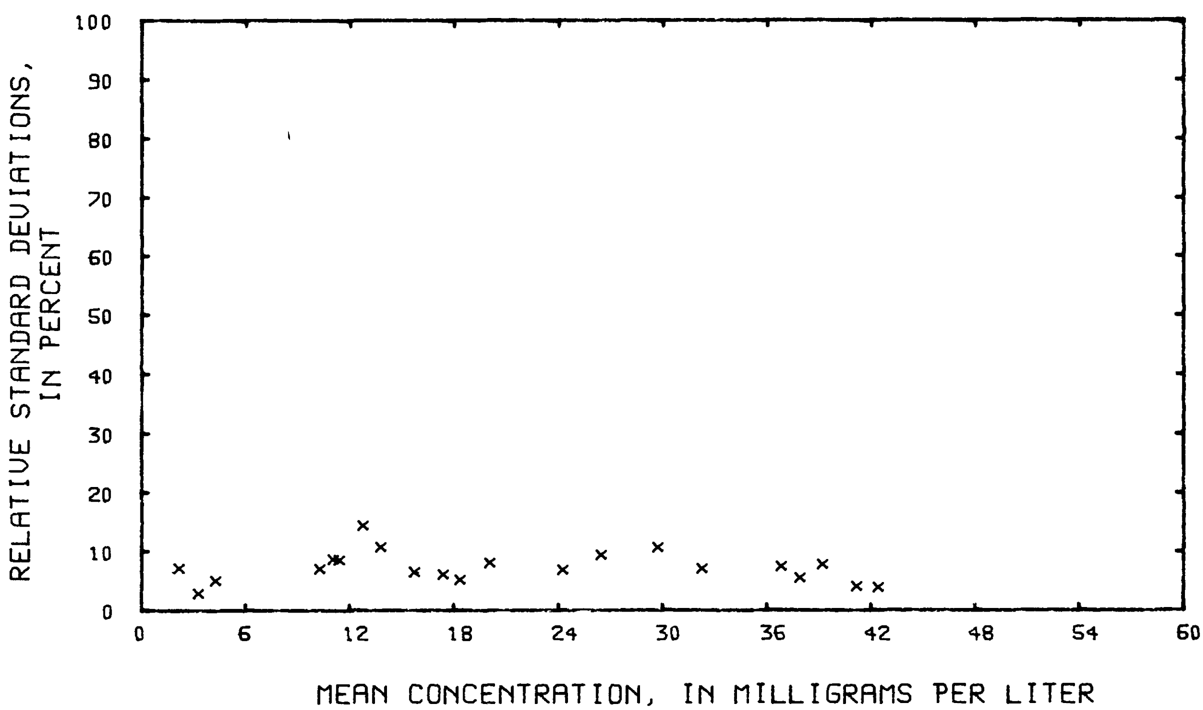


Figure 156.--Precision data for chloride, dissolved, at the Denver laboratory.

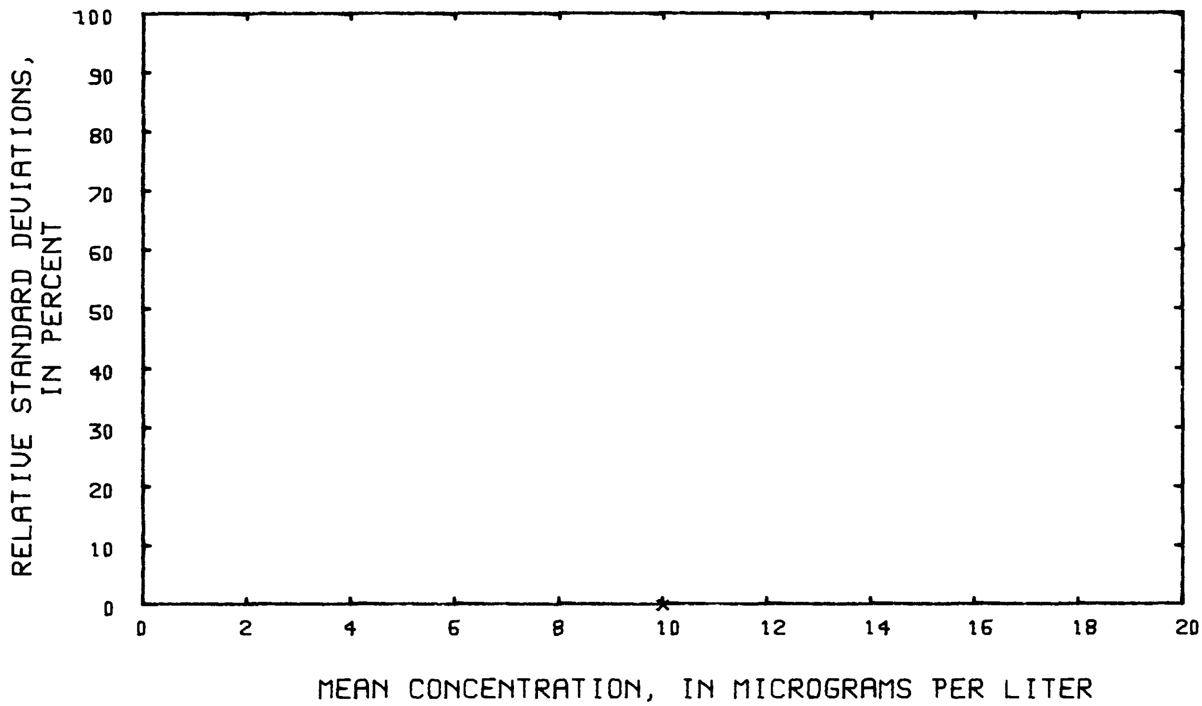


Figure 157.--Precision data for chromium, dissolved, at the Atlanta laboratory.

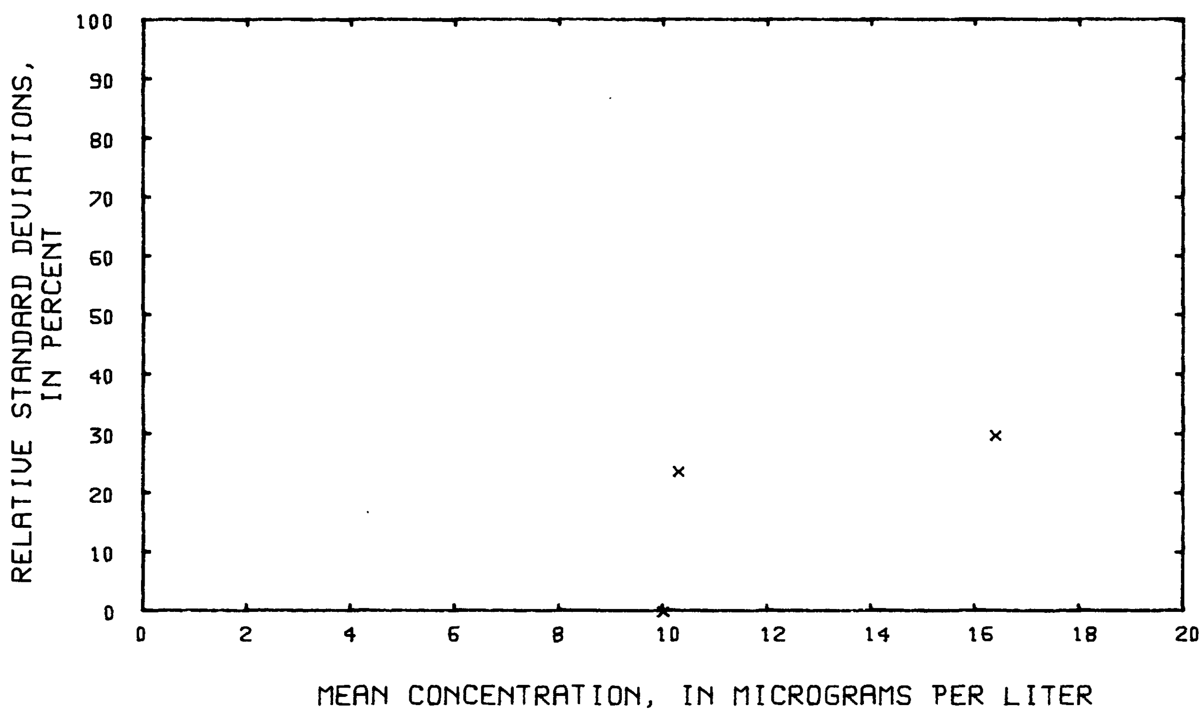


Figure 158.--Precision data for chromium, dissolved, at the Denver laboratory.

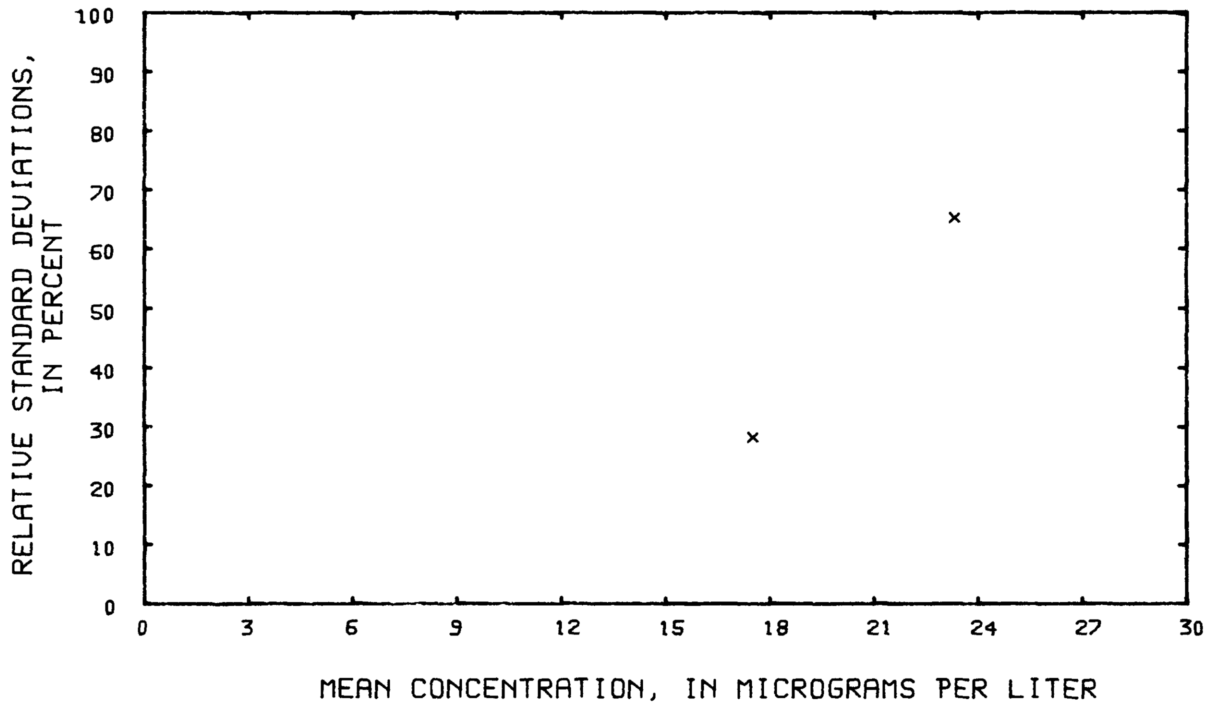


Figure 159.--Precision data for chromium, total recoverable, at the Atlanta laboratory.

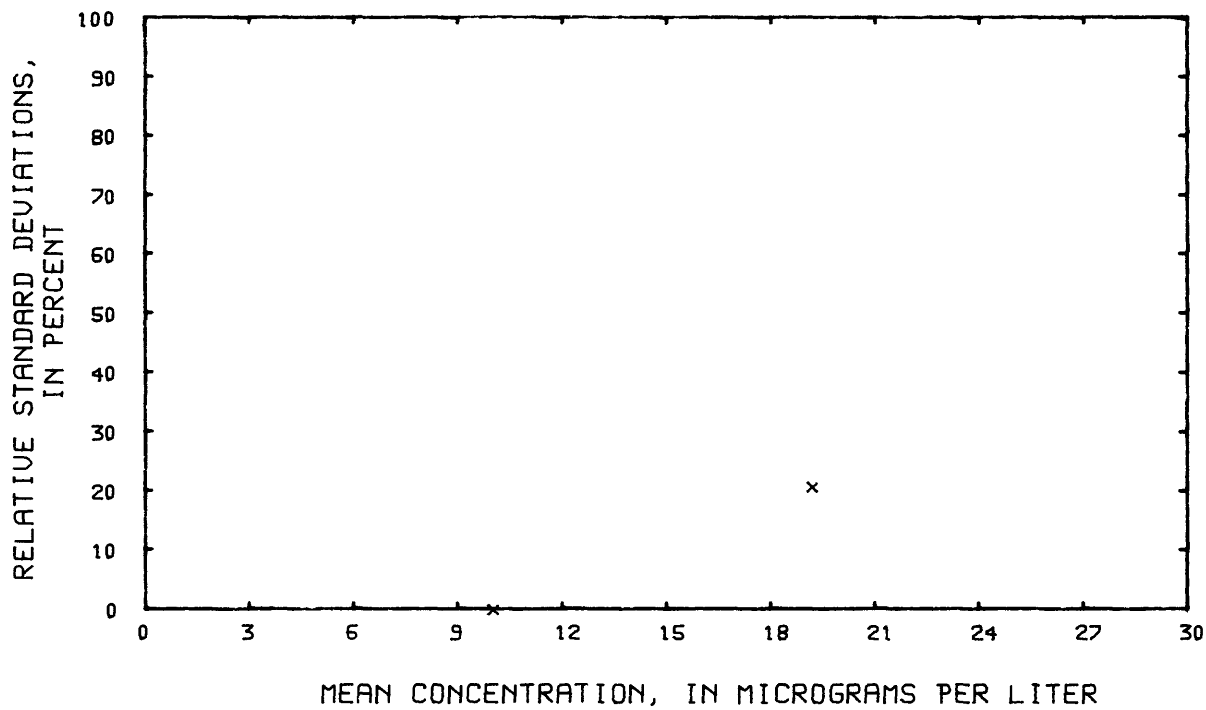


Figure 160.--Precision data for chromium, total recoverable, at the Denver laboratory.

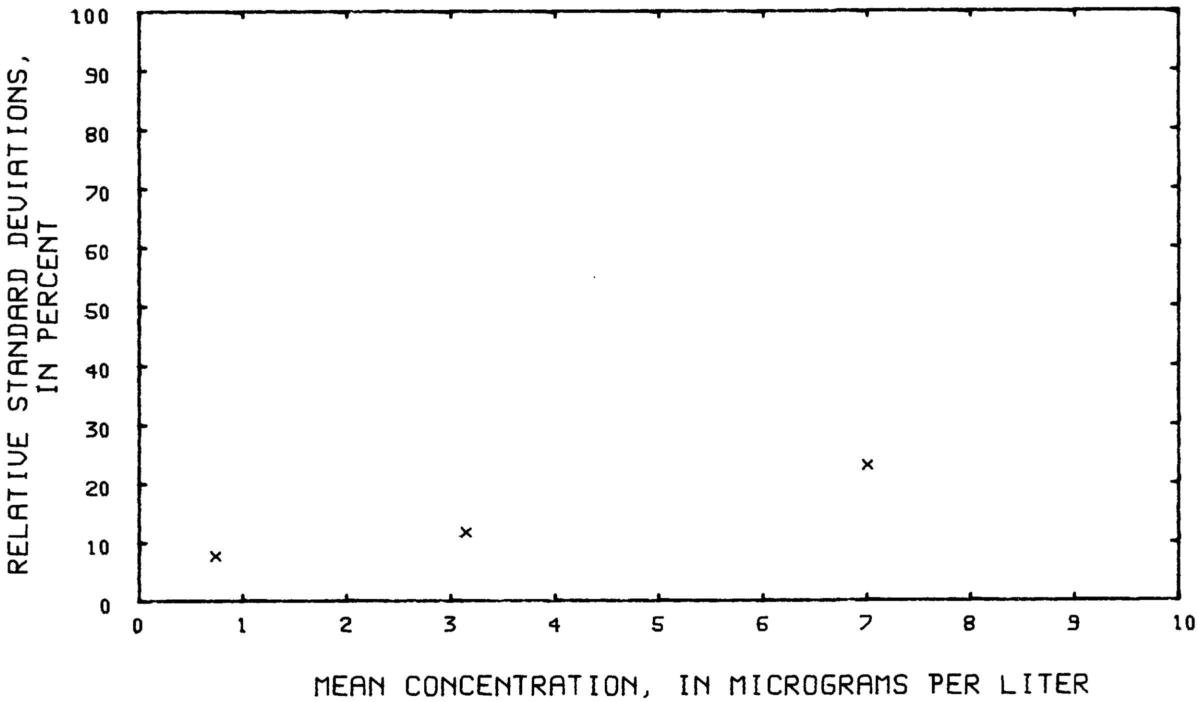


Figure 161.--Precision data for cobalt, dissolved, (inductively coupled plasma emission spectrometry) at the Atlanta laboratory.

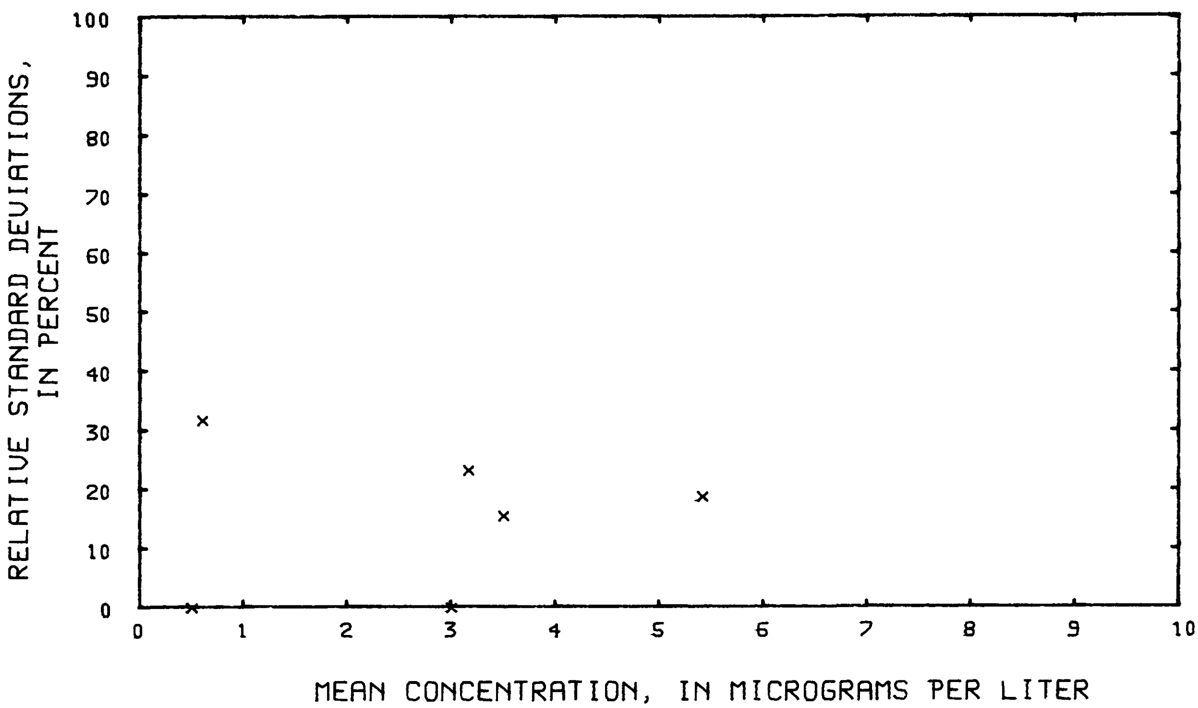


Figure 162.--Precision data for cobalt, dissolved, (inductively coupled plasma emission spectrometry) at the Denver laboratory.

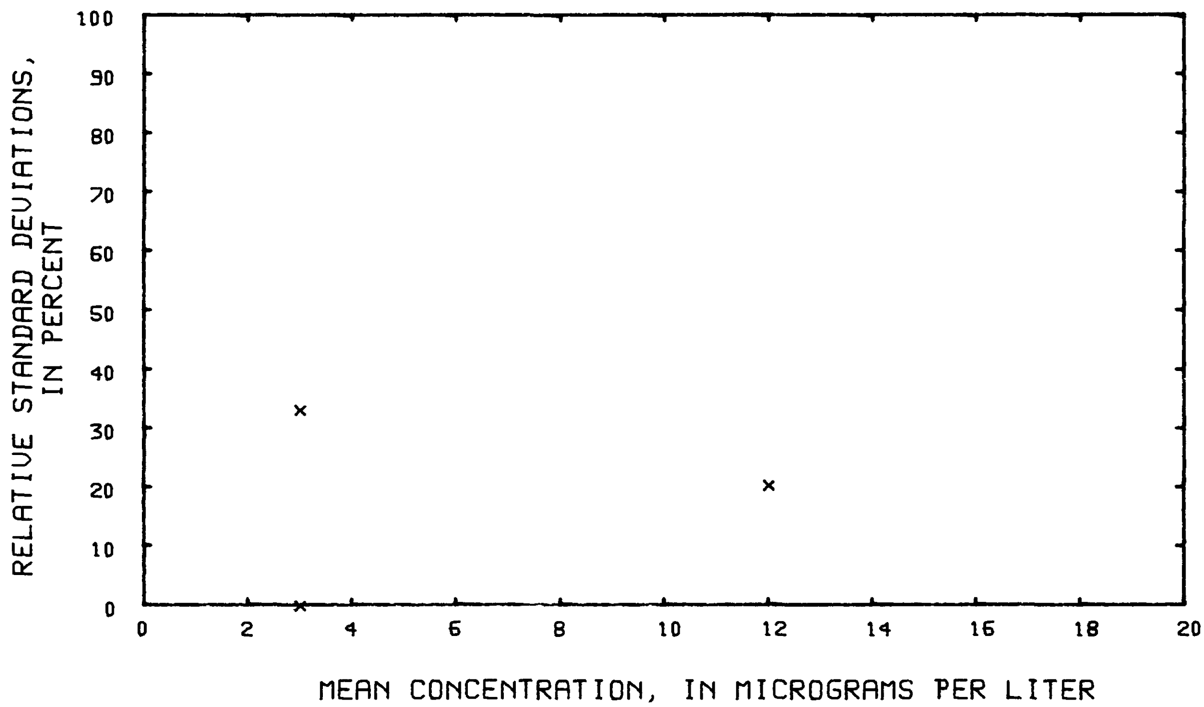


Figure 163.--Precision data for cobalt, dissolved, (atomic absorption spectrometry) at the Atlanta laboratory.

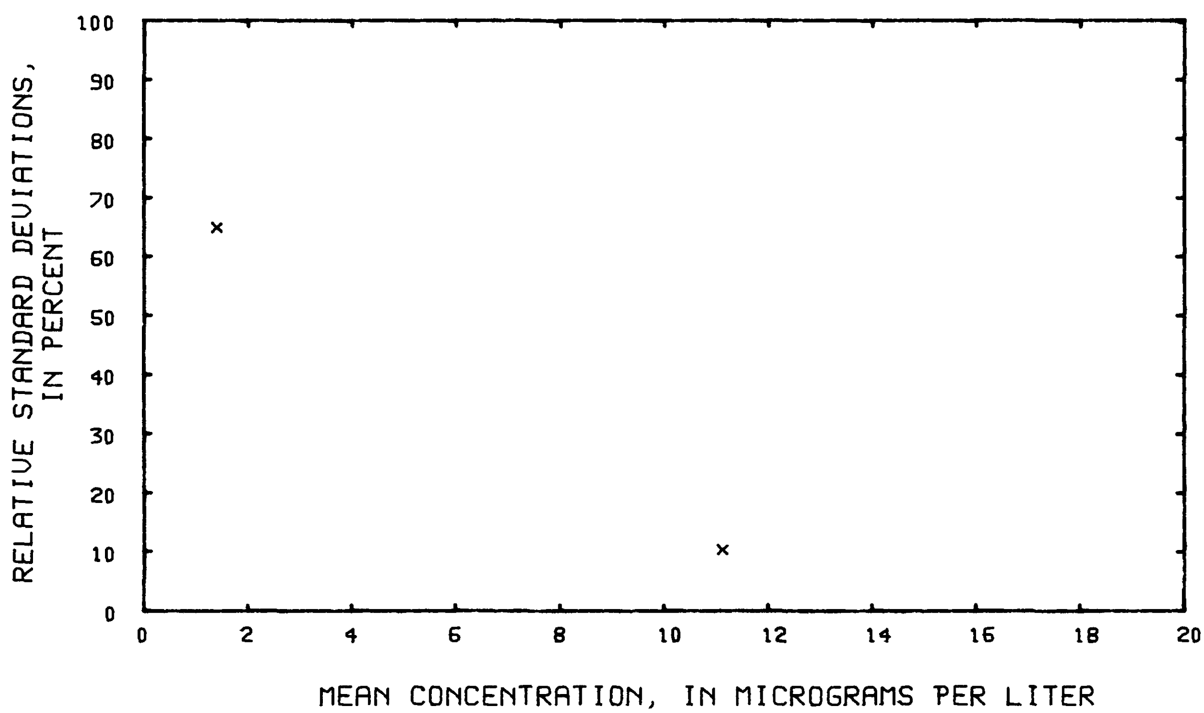


Figure 164.--Precision data for cobalt, dissolved, (atomic absorption spectrometry) at the Denver laboratory.

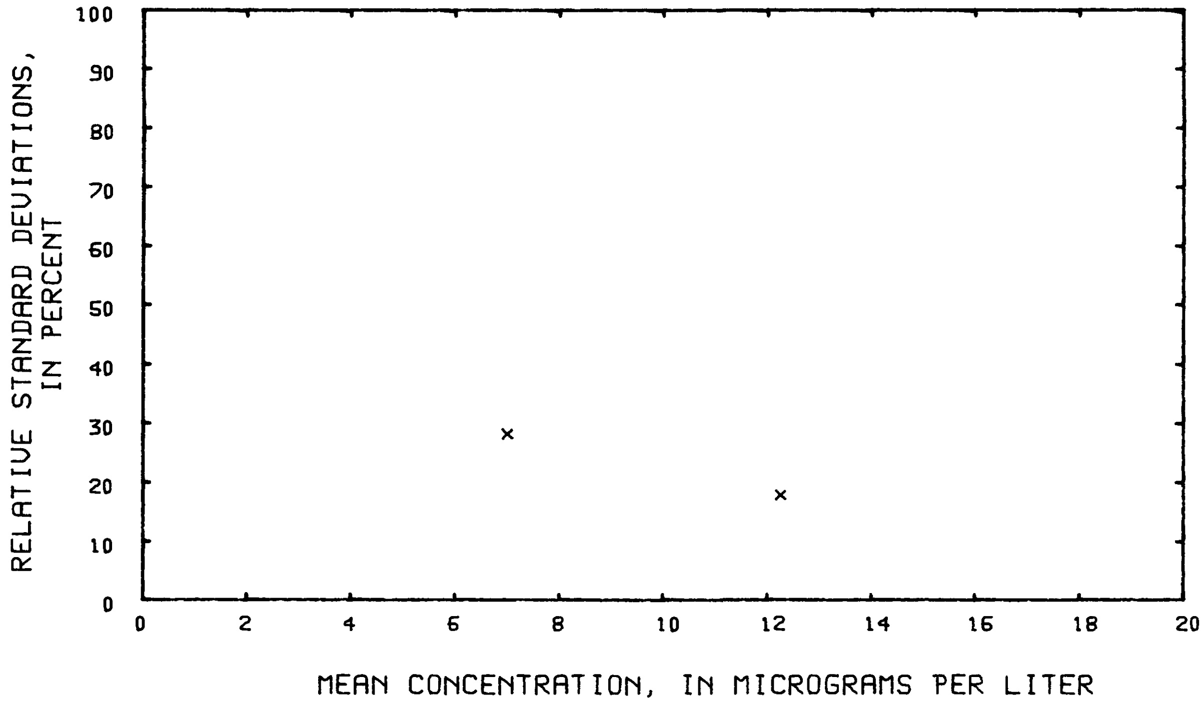


Figure 165.--Precision data for cobalt, total recoverable, at the Atlanta laboratory.

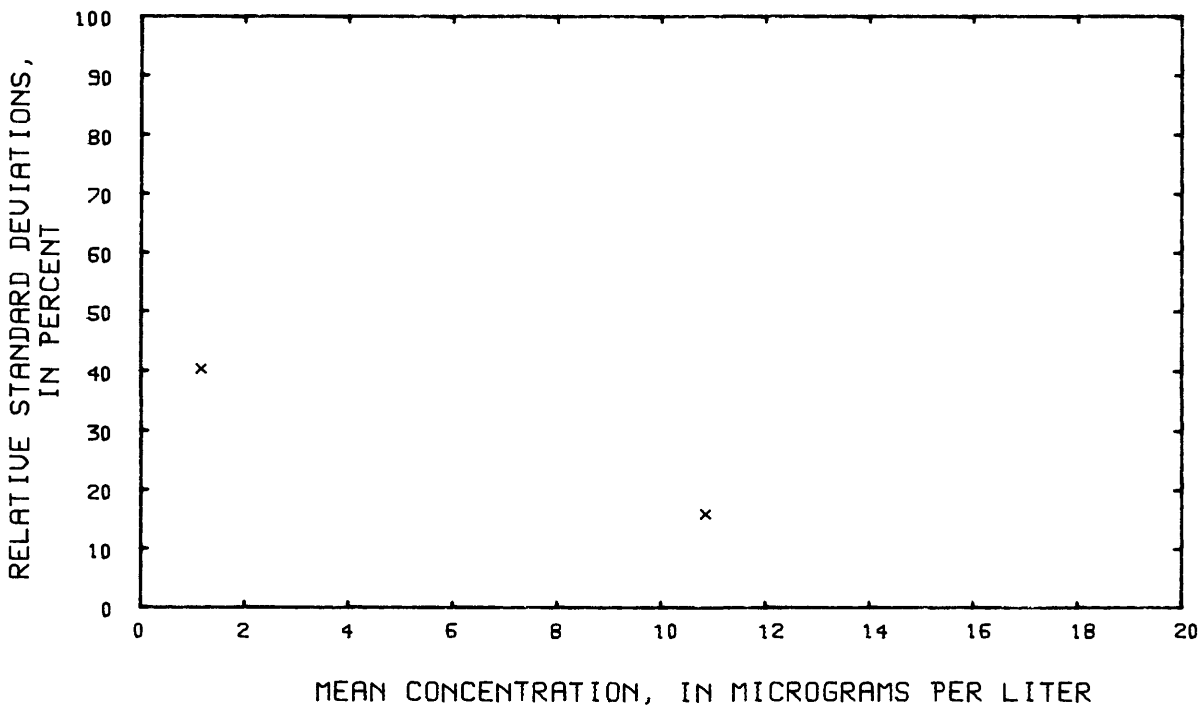


Figure 166.--Precision data for cobalt, total recoverable, at the Denver laboratory.

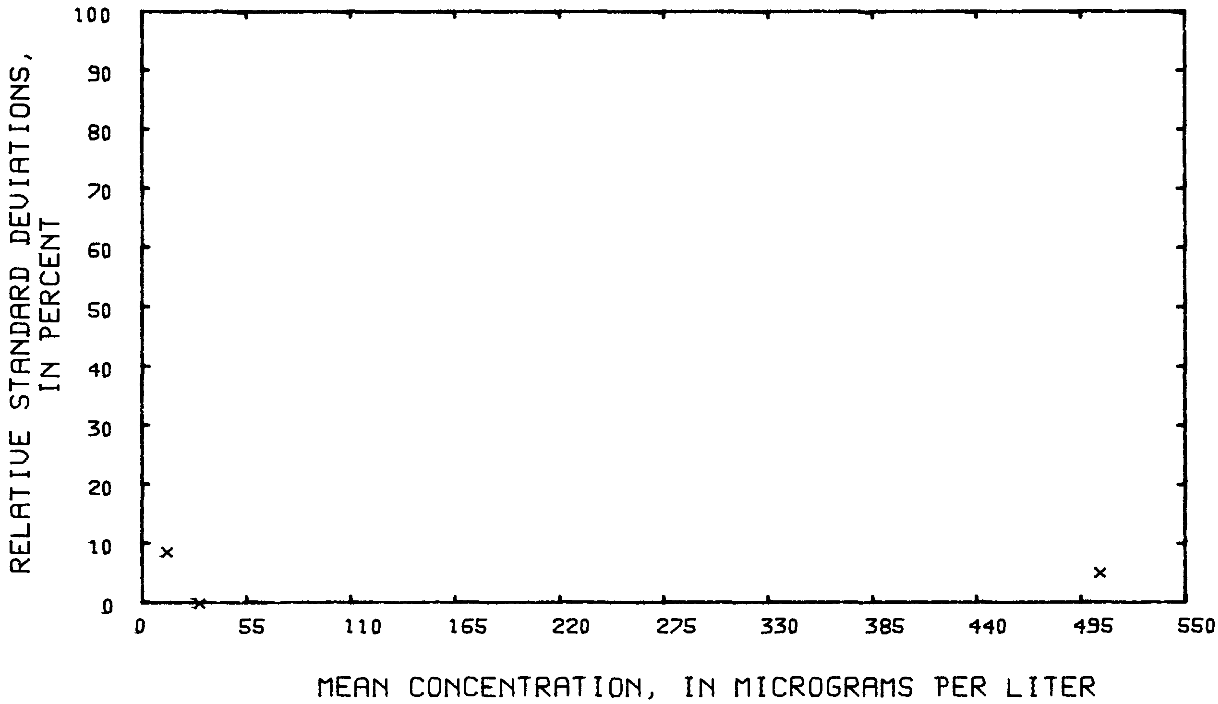


Figure 167.--Precision data for copper, dissolved, (inductively coupled plasma emission spectrometry) at the Atlanta laboratory.

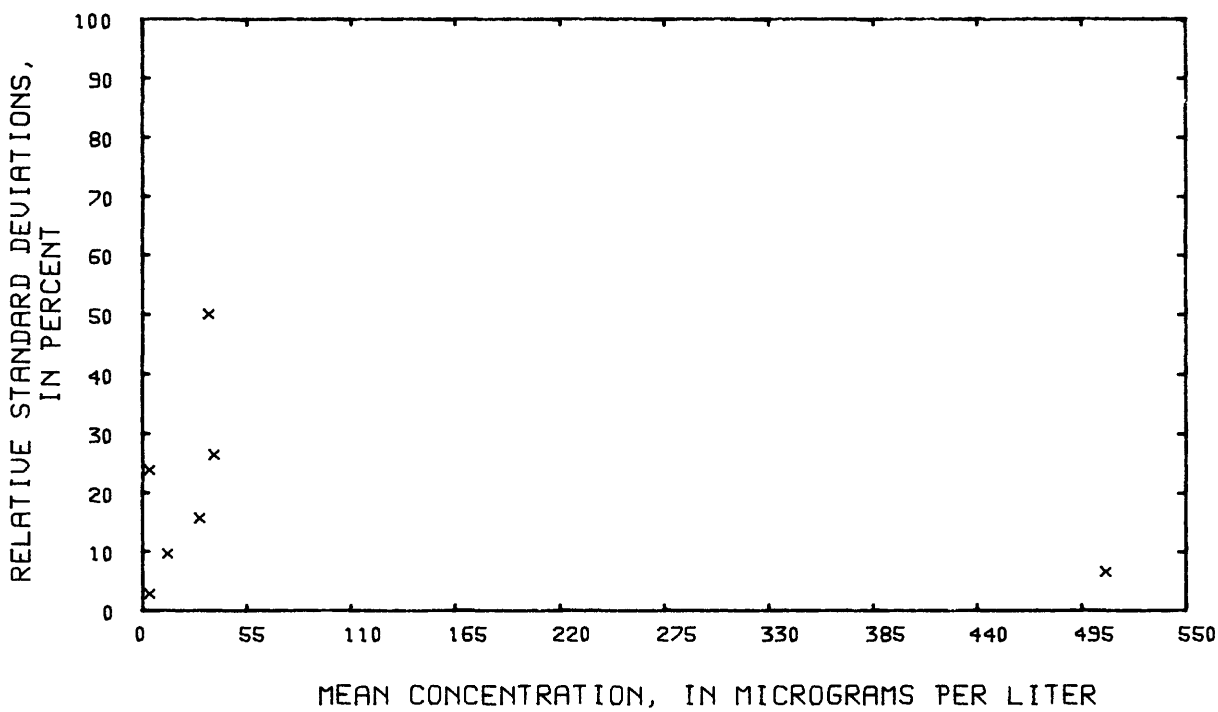


Figure 168.--Precision data for copper, dissolved, (inductively coupled plasma emission spectrometry) at the Denver laboratory.

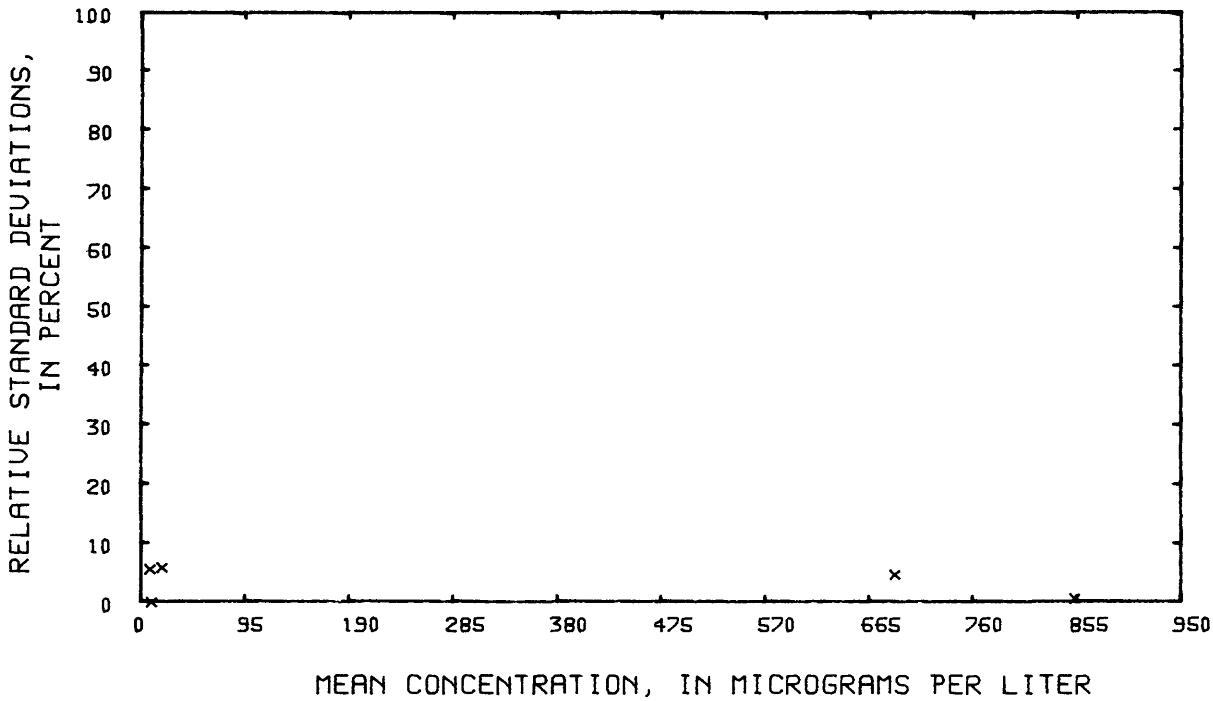


Figure 169.--Precision data for copper, dissolved, (atomic absorption spectrometry) at the Atlanta laboratory.

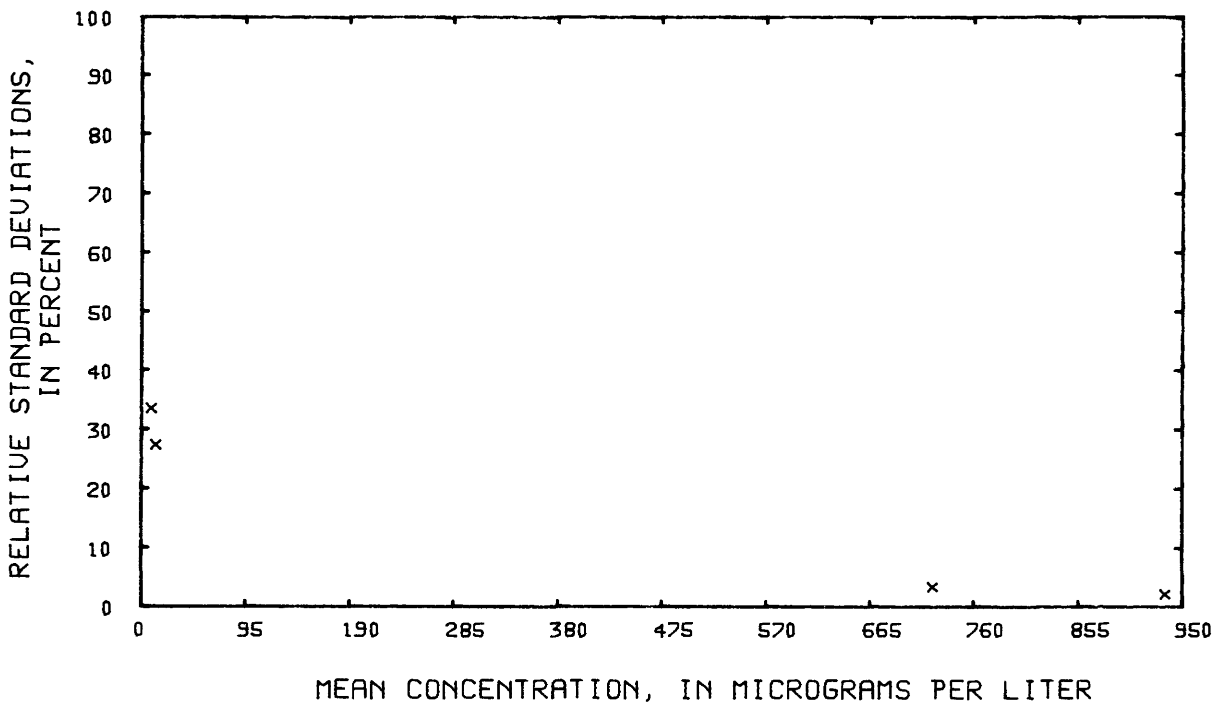


Figure 170.--Precision data for copper, dissolved, (atomic absorption spectrometry) at the Denver laboratory.

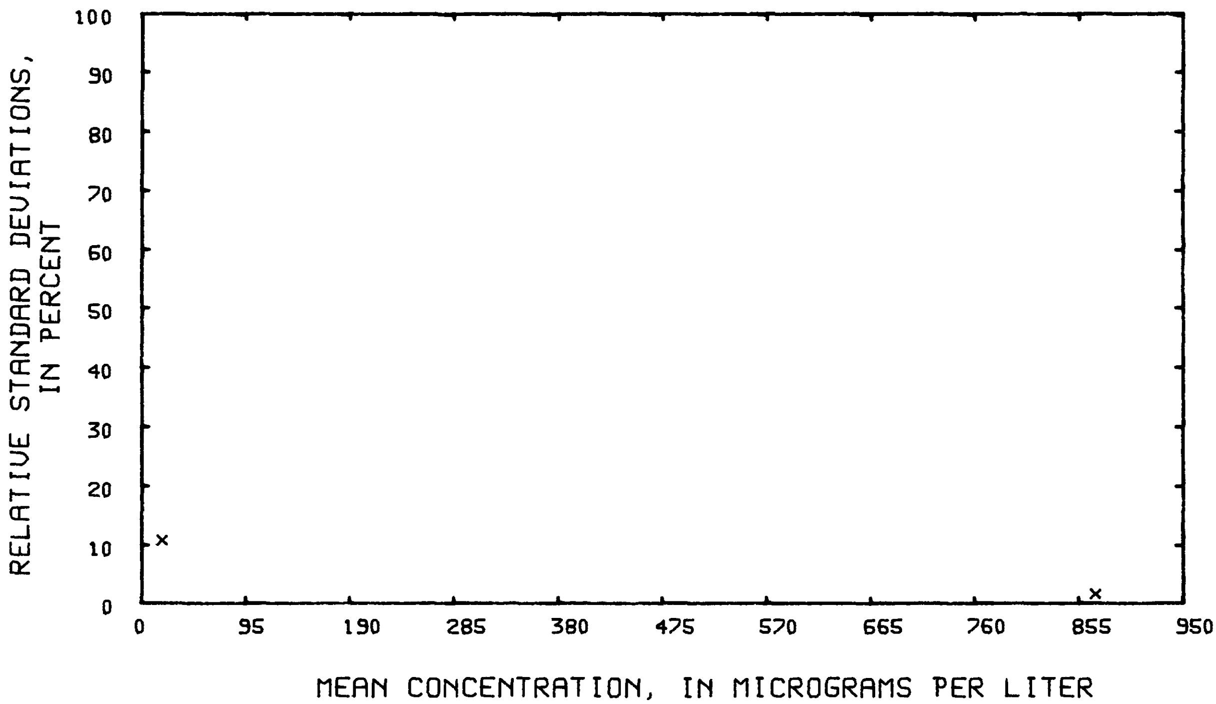


Figure 171.--Precision data for copper, total recoverable, at the Atlanta laboratory.

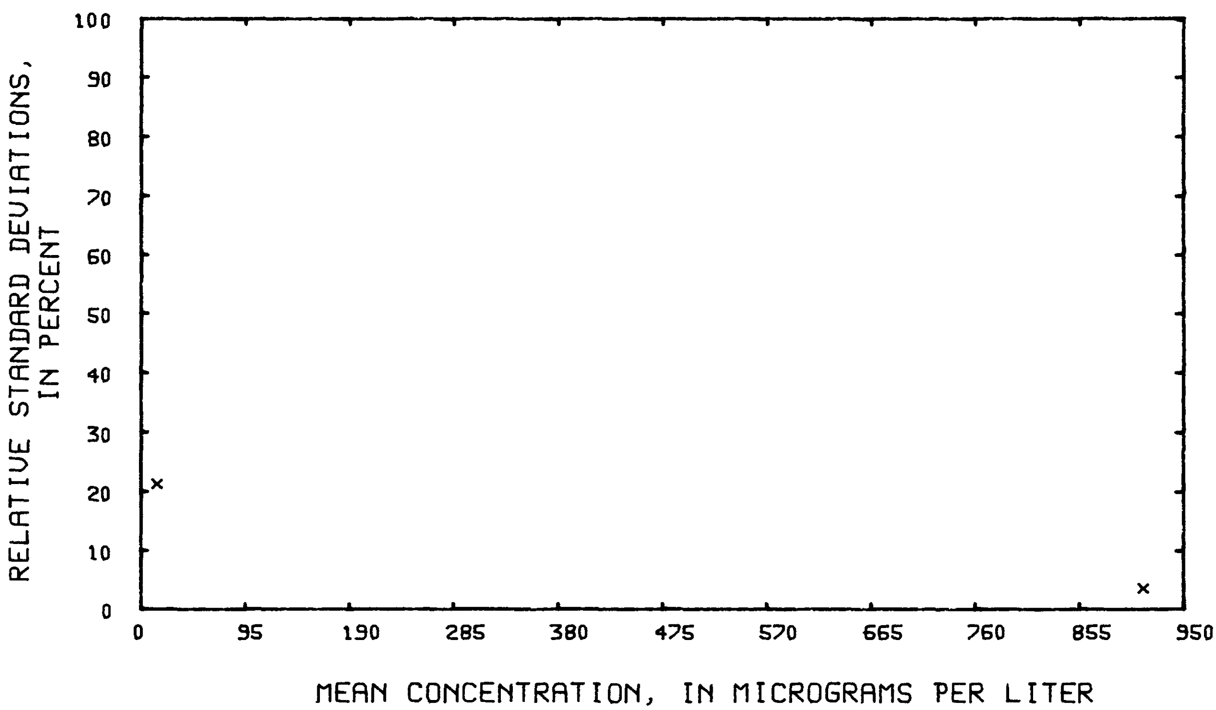


Figure 172.--Precision data for copper, total recoverable, at the Denver laboratory.

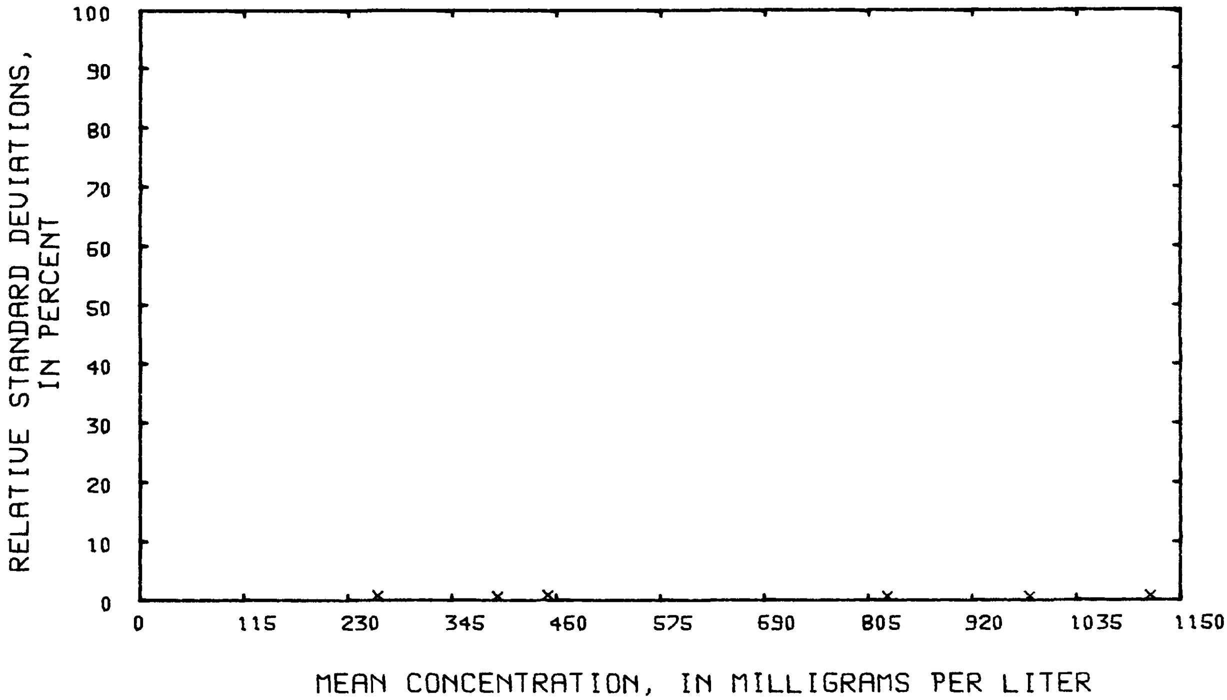


Figure 173.--Precision data for dissolved solids at the Atlanta laboratory.

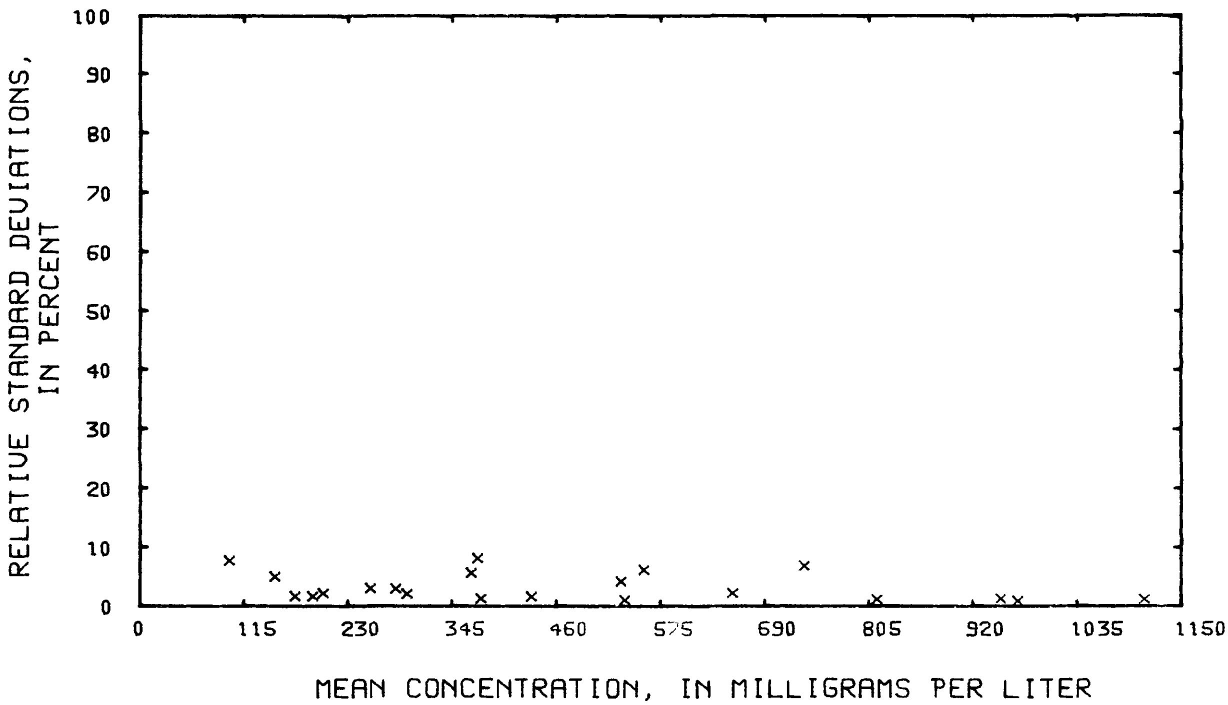


Figure 174.--Precision data for dissolved solids at the Denver laboratory.

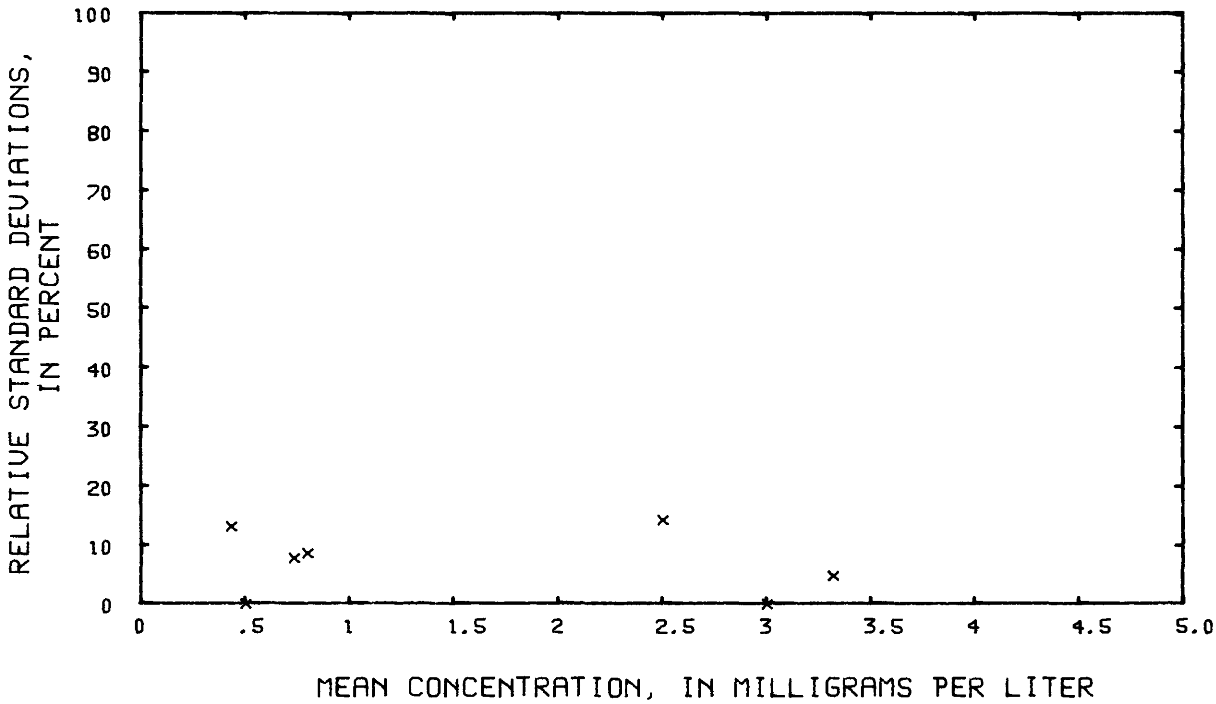


Figure 175.--Precision data for fluoride, dissolved, at the Atlanta laboratory.

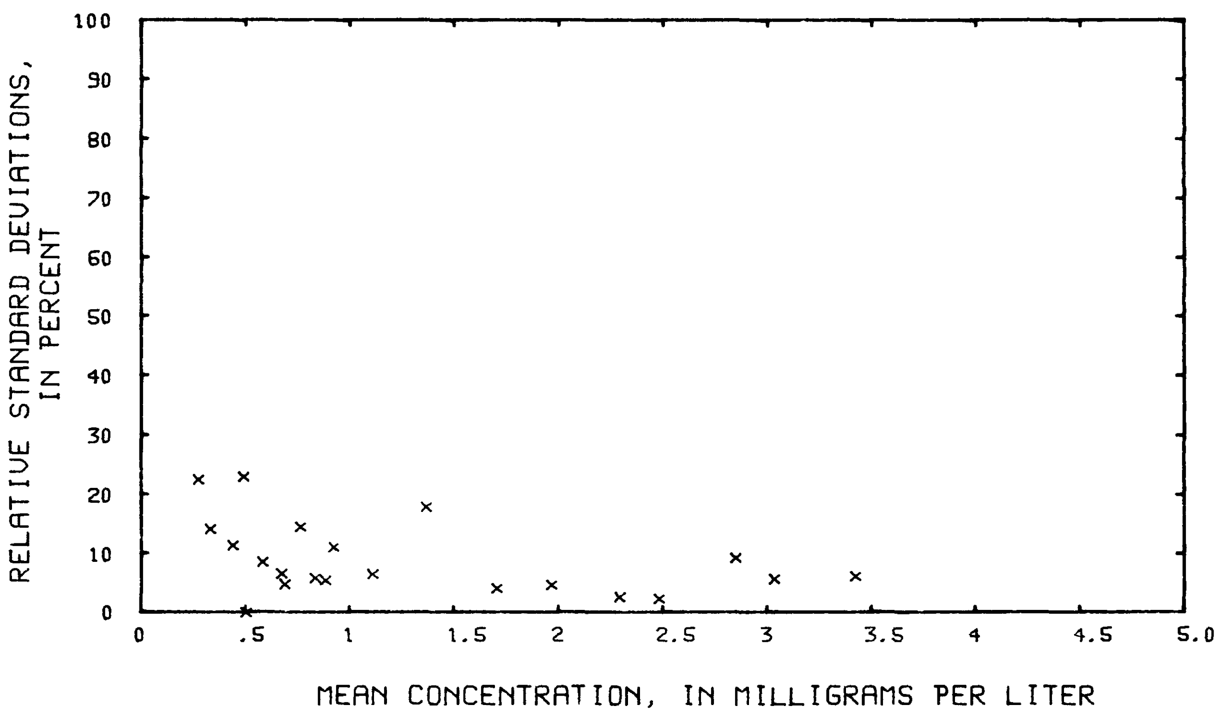


Figure 176.--Precision data for fluoride, dissolved, at the Denver laboratory.

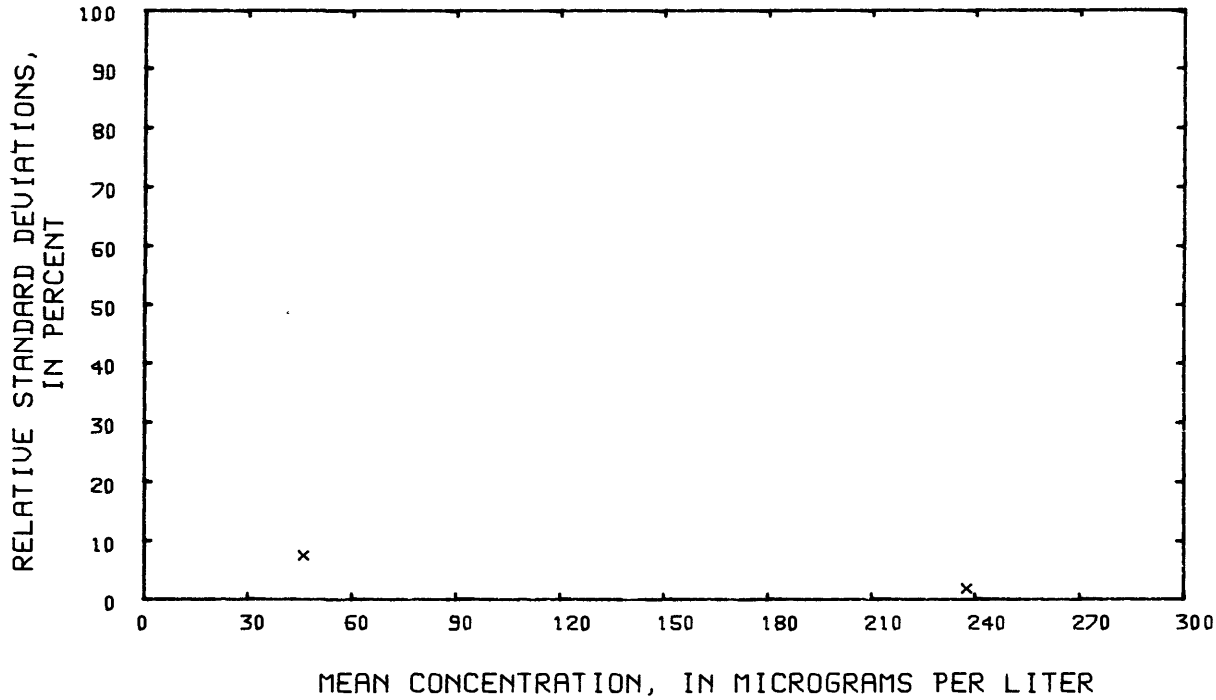


Figure 177.--Precision data for iron, dissolved, (inductively coupled plasma emission spectrometry) at the Atlanta laboratory.

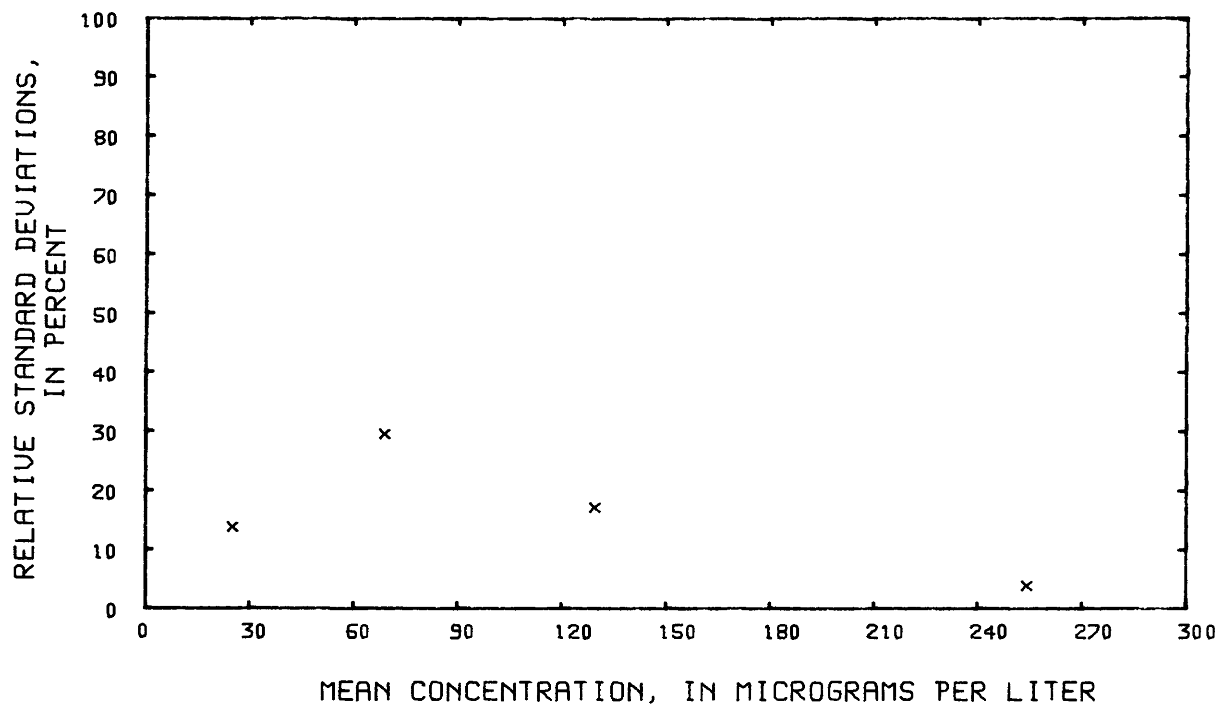


Figure 178.--Precision data for iron, dissolved, (inductively coupled plasma emission spectrometry) at the Denver laboratory.

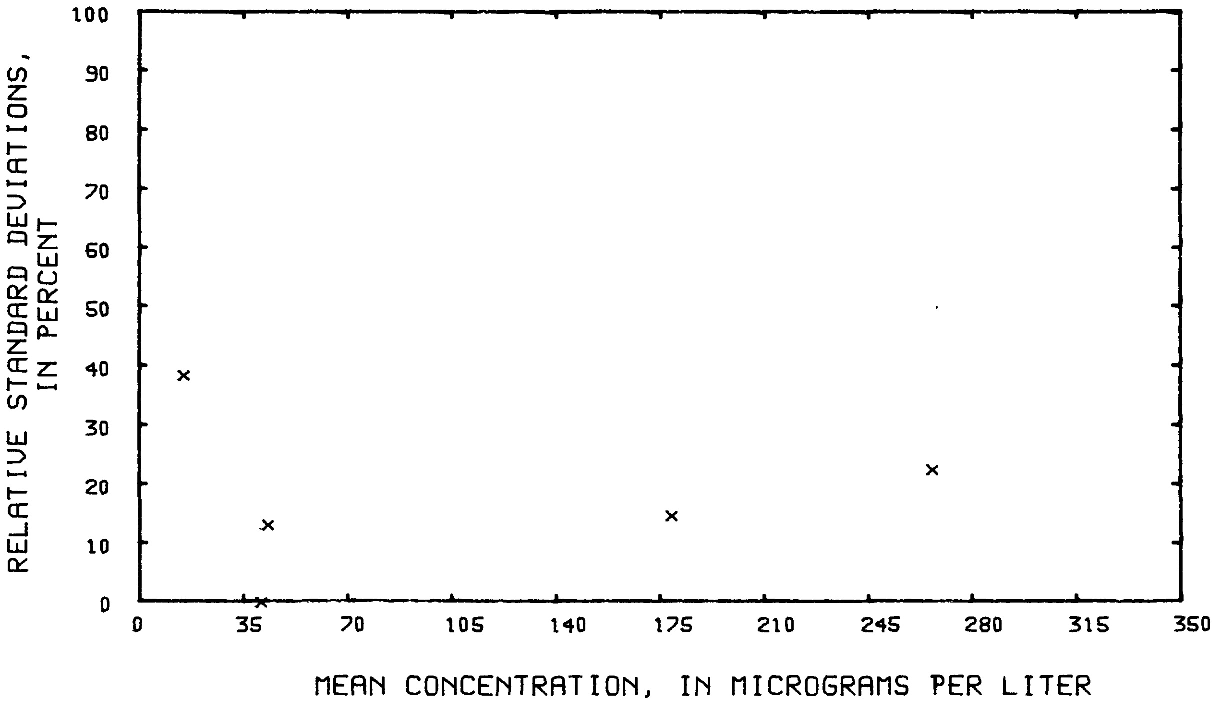


Figure 179.--Precision data for iron, dissolved, (atomic absorption spectrometry) at the Atlanta laboratory.

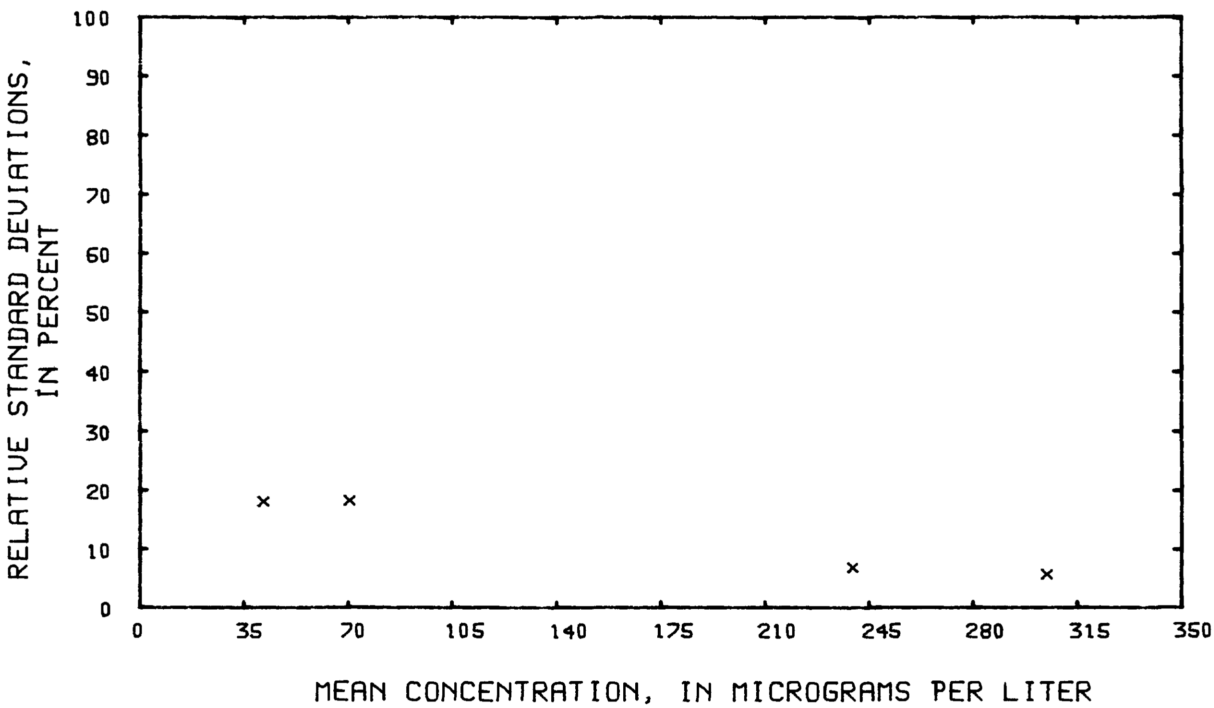


Figure 180.--Precision data for iron, dissolved, (atomic absorption spectrometry) at the Denver laboratory.

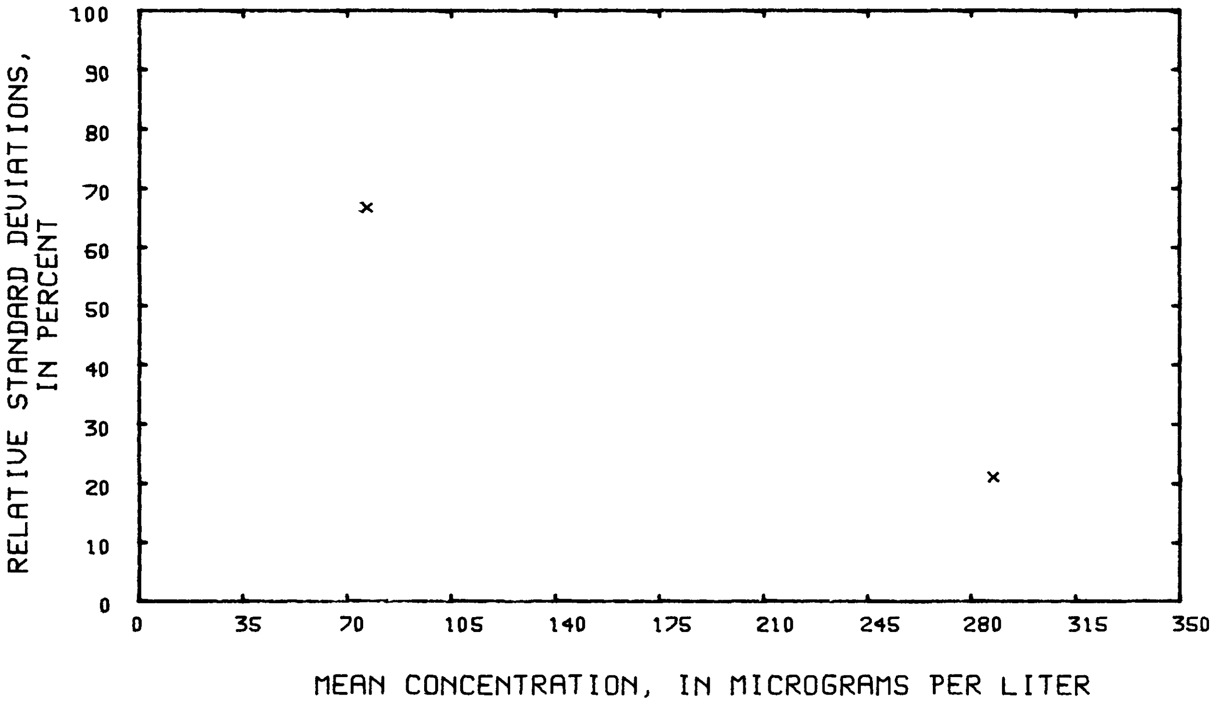


Figure 181.--Precision data for iron, total recoverable, at the Atlanta laboratory.

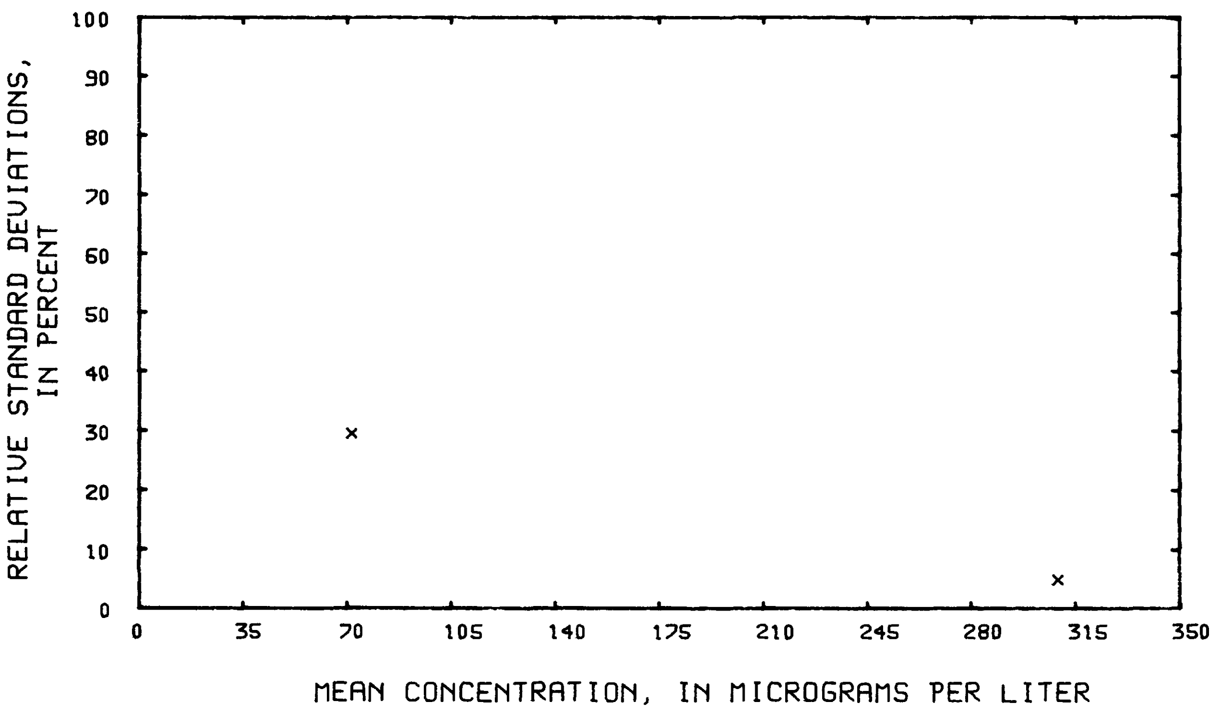


Figure 182.--Precision data for iron, total recoverable, at the Denver laboratory.

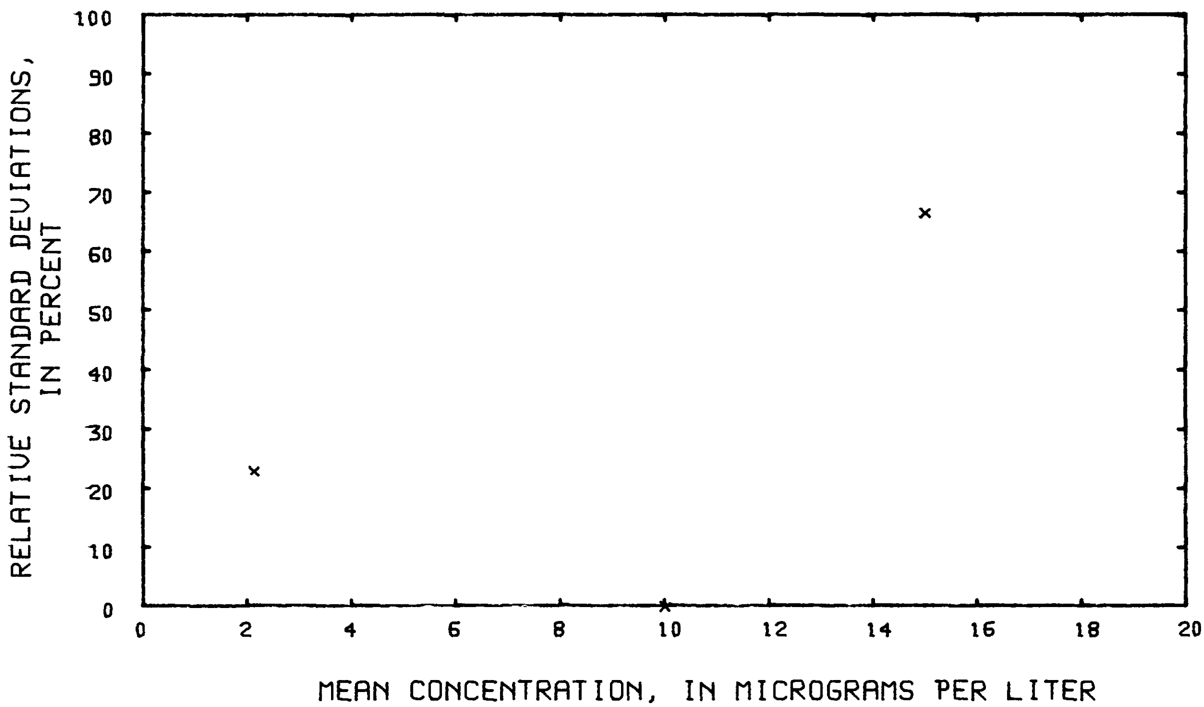


Figure 183.--Precision data for lead, dissolved, (inductively coupled plasma emission spectrometry) at the Atlanta laboratory.

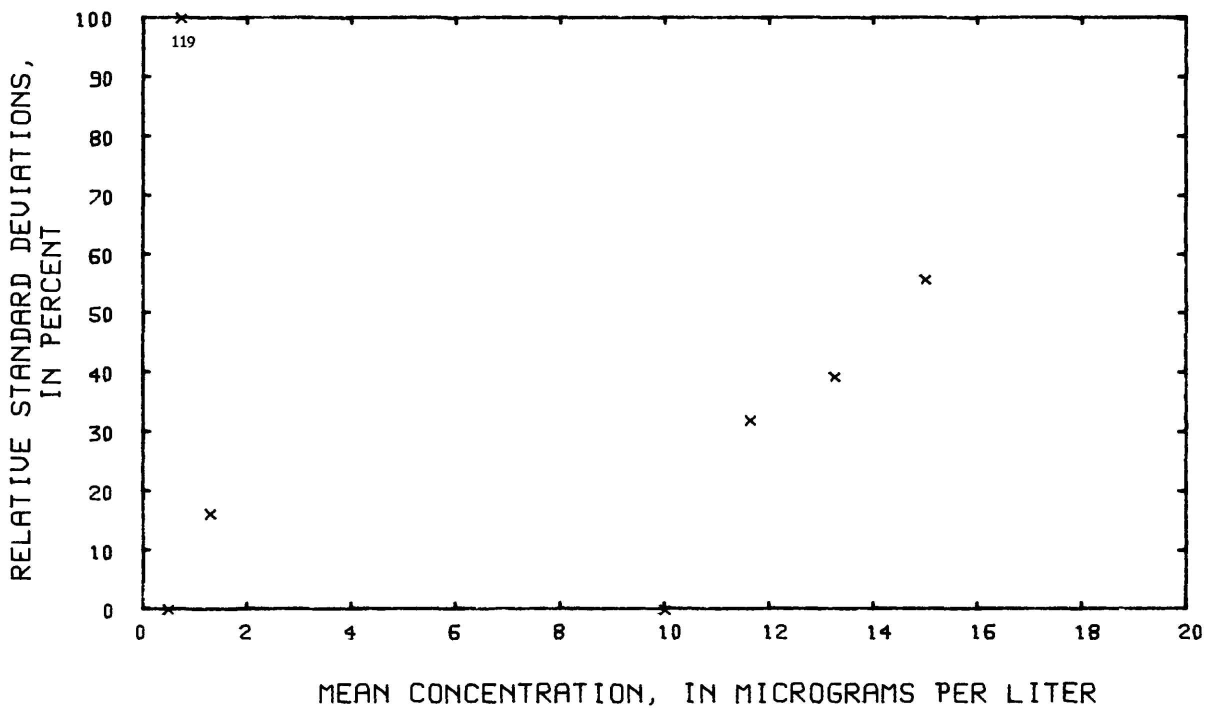


Figure 184.--Precision data for lead, dissolved, (inductively coupled plasma emission spectrometry) at the Denver laboratory.

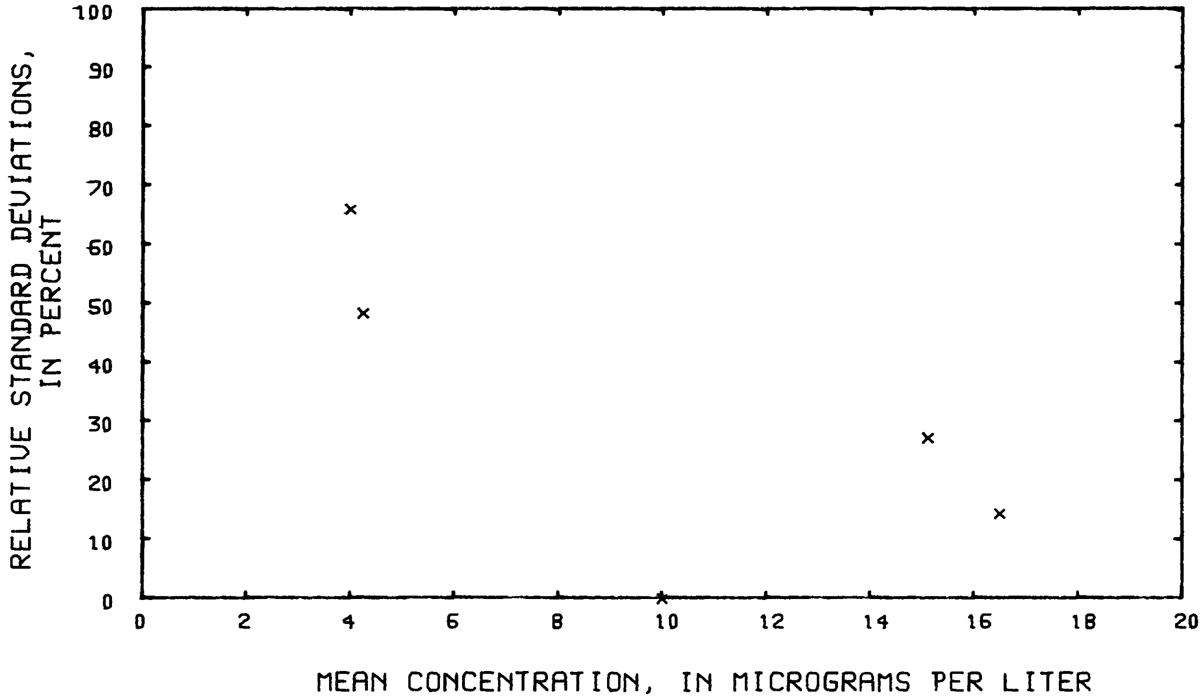


Figure 185.--Precision data for lead, dissolved, (atomic absorption spectrometry) at the Atlanta laboratory.

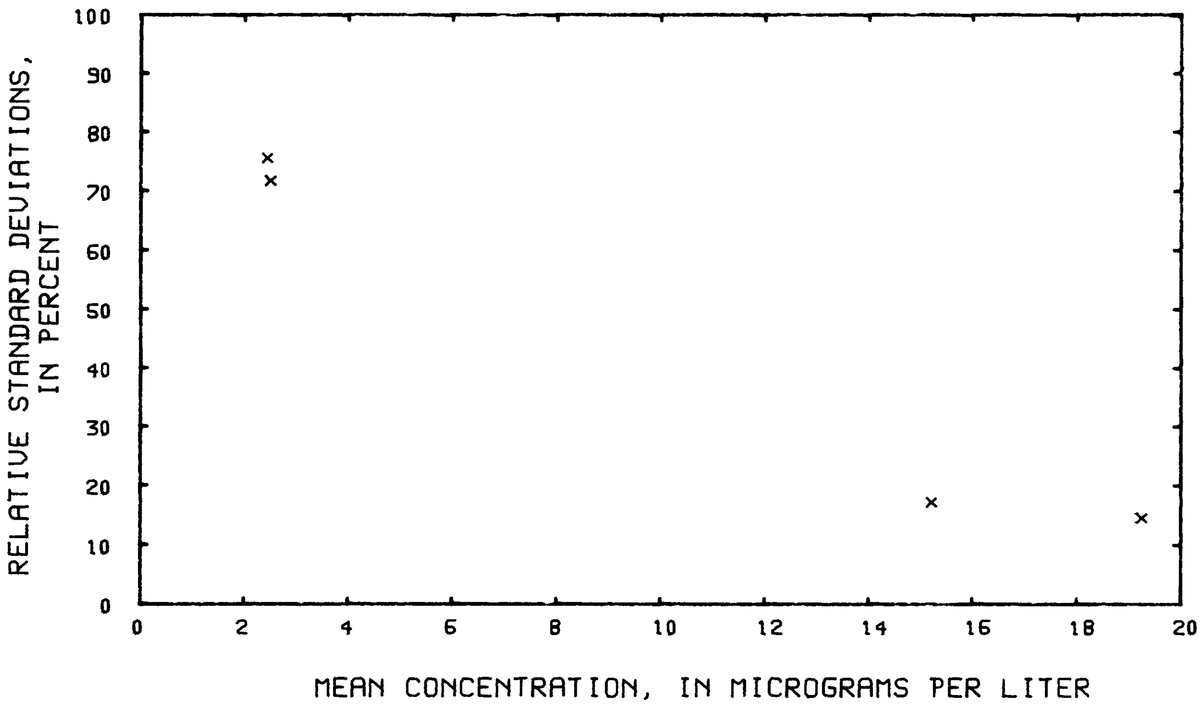


Figure 186.--Precision data for lead, dissolved, (atomic absorption spectrometry) at the Denver laboratory.

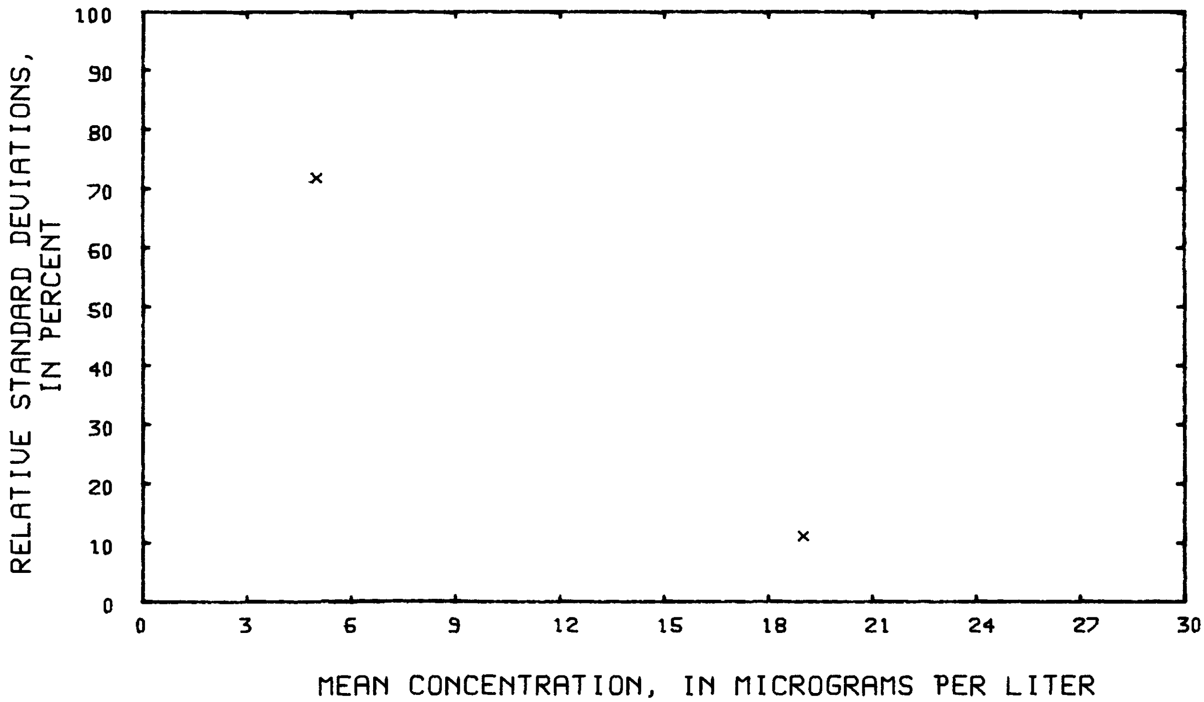


Figure 187.--Precision data for lead, total recoverable, at the Atlanta laboratory.

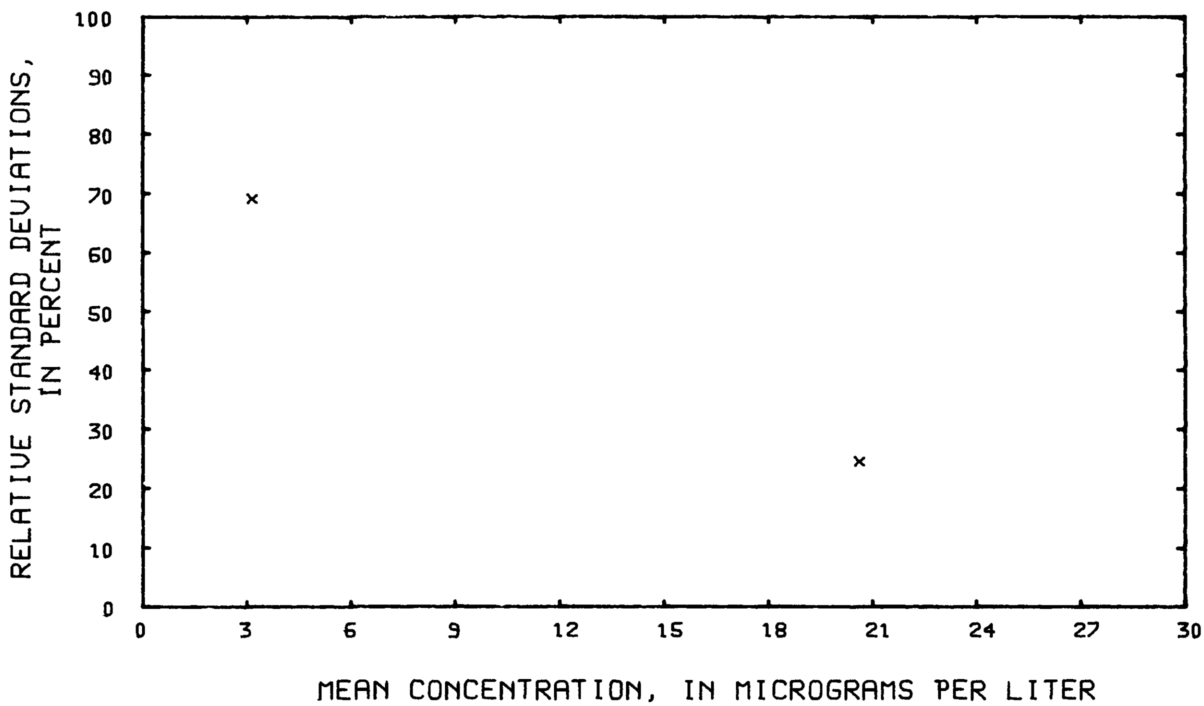


Figure 188.--Precision data for lead, total recoverable, at the Denver laboratory.

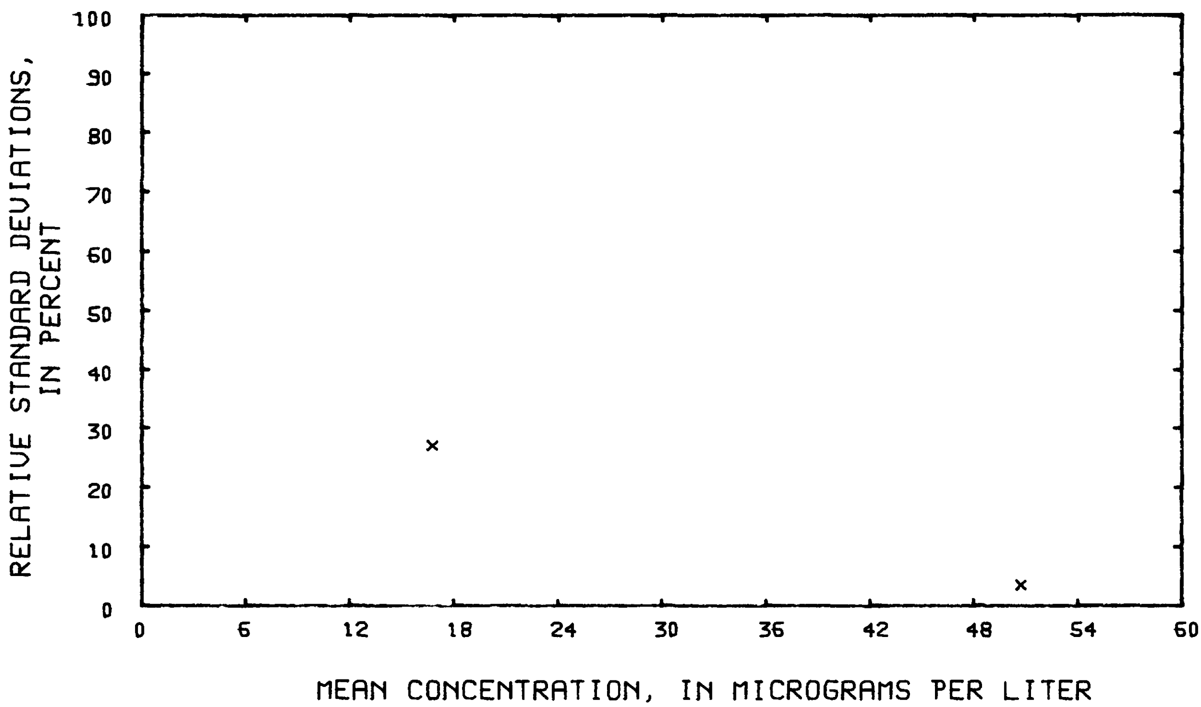


Figure 189.--Precision data for lithium, dissolved, at the Atlanta laboratory.

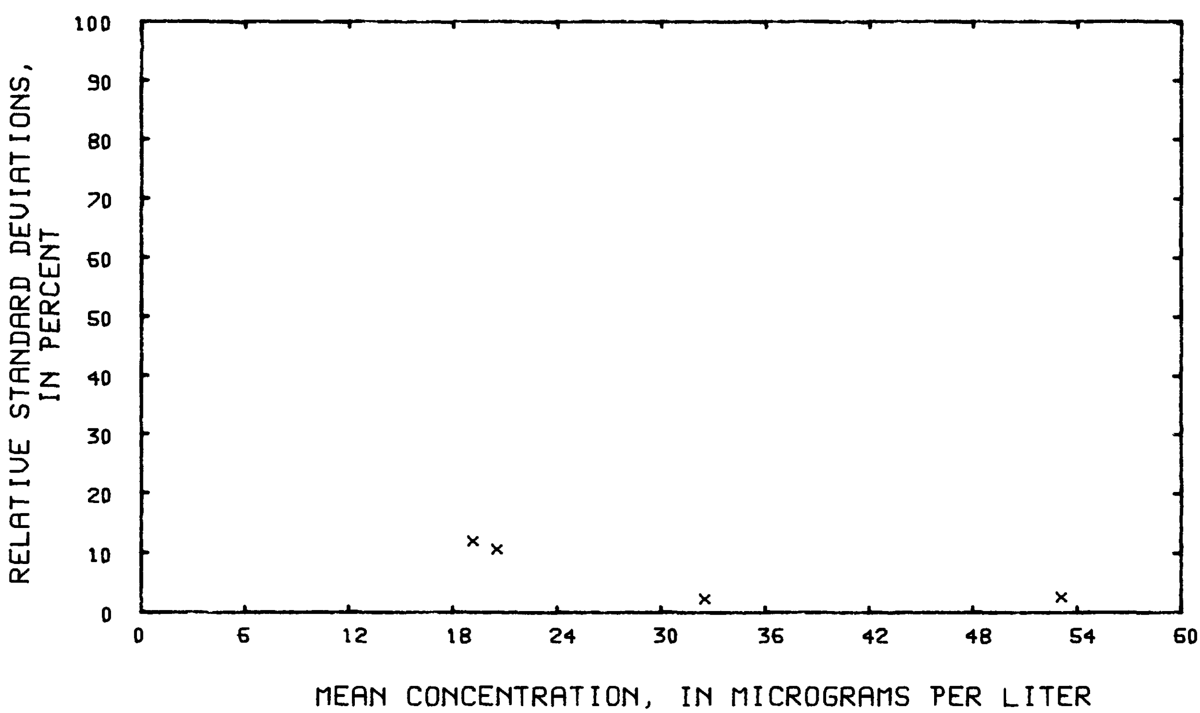


Figure 190.--Precision data for lithium, dissolved, at the Denver laboratory.

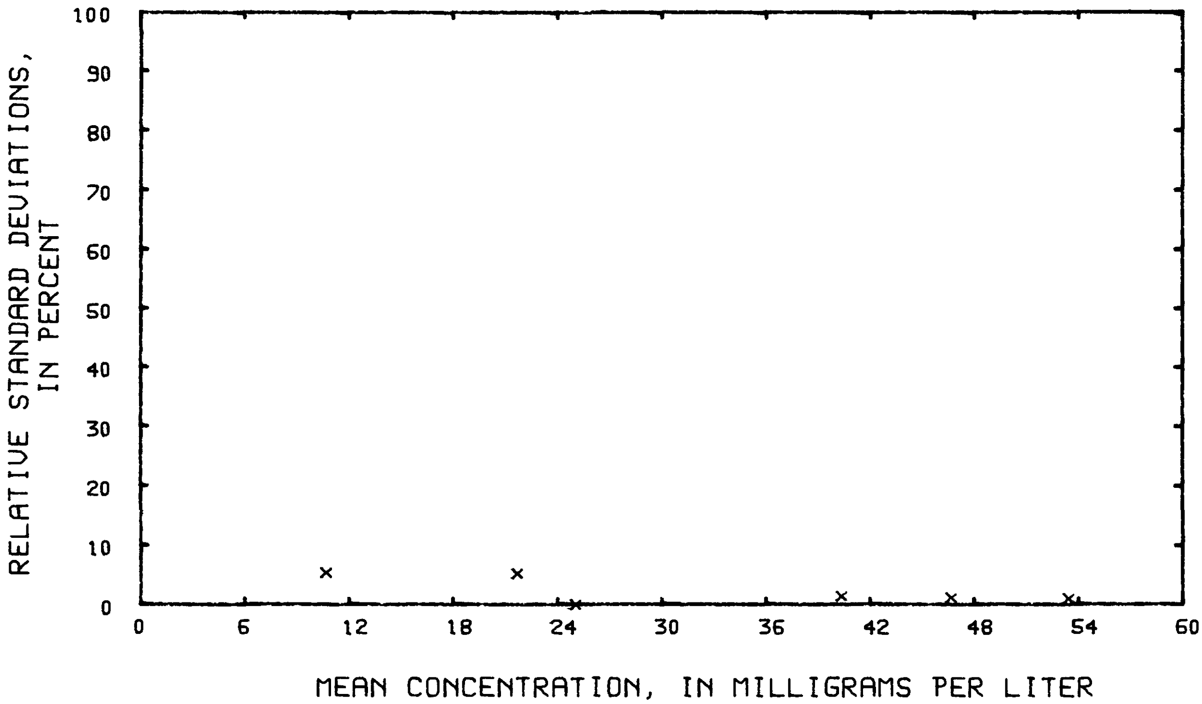


Figure 191.--Precision data for magnesium, dissolved, (inductively coupled plasma emission spectrometry) at the Atlanta laboratory.

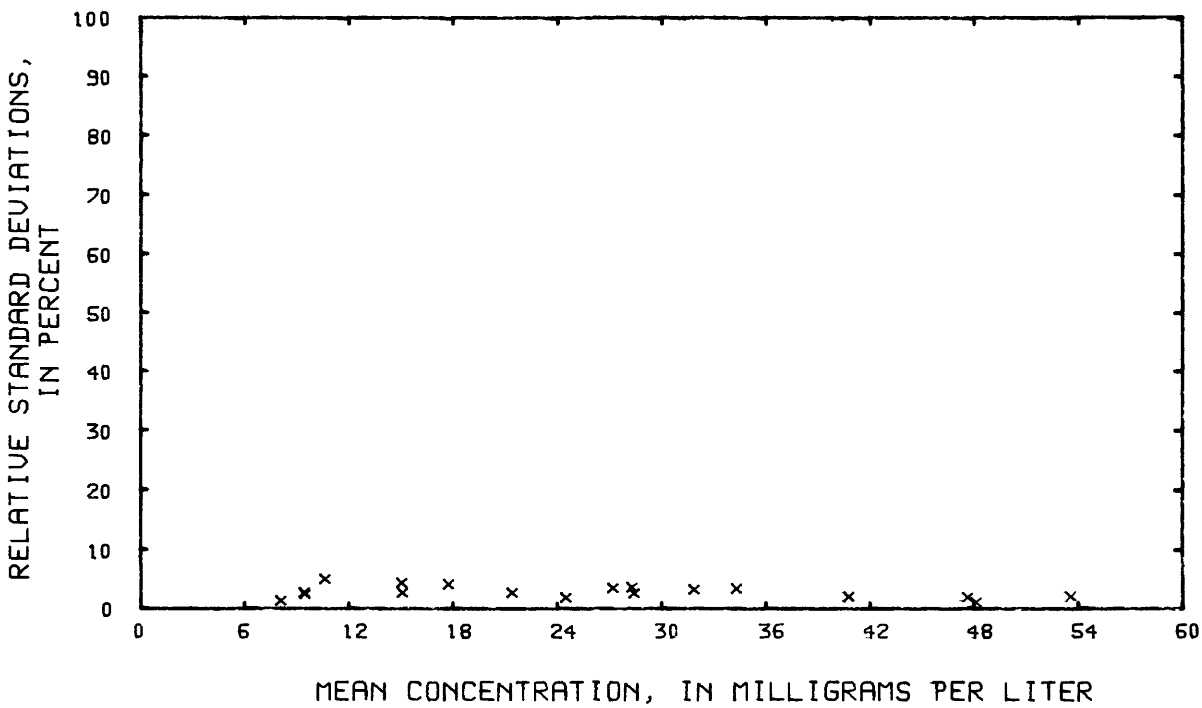


Figure 192.--Precision data for magnesium, dissolved, (inductively coupled plasma emission spectrometry) at the Denver laboratory.

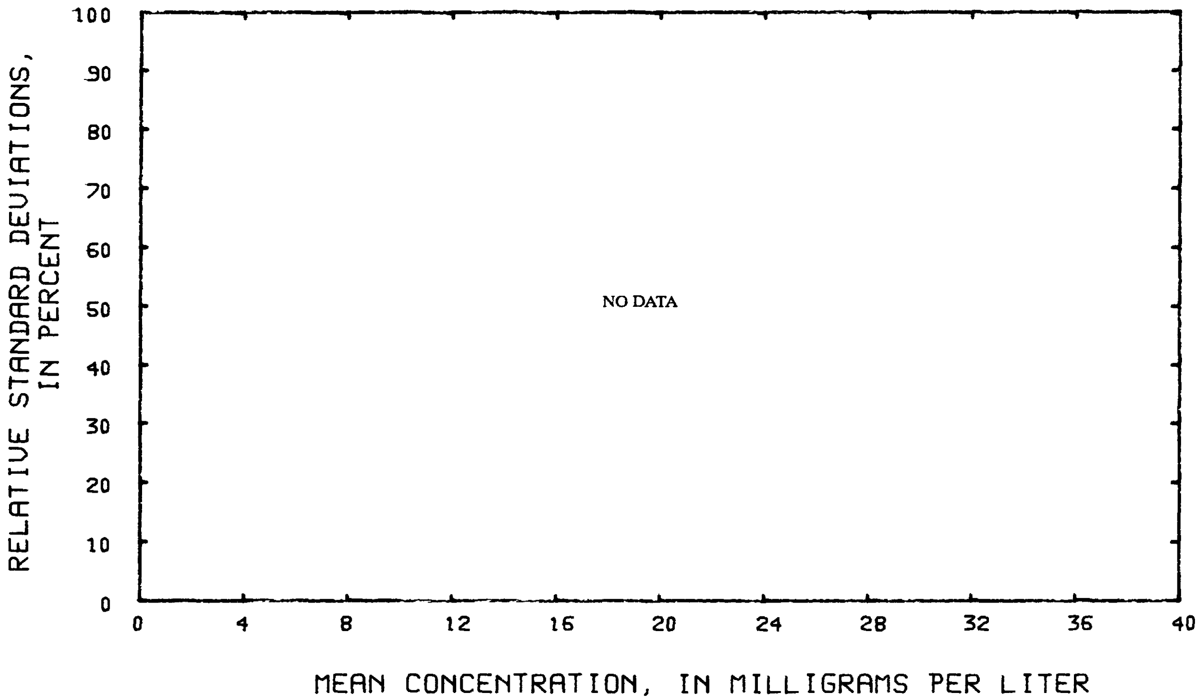


Figure 193.--Precision data for magnesium, dissolved, (atomic absorption spectrometry) at the Atlanta laboratory.

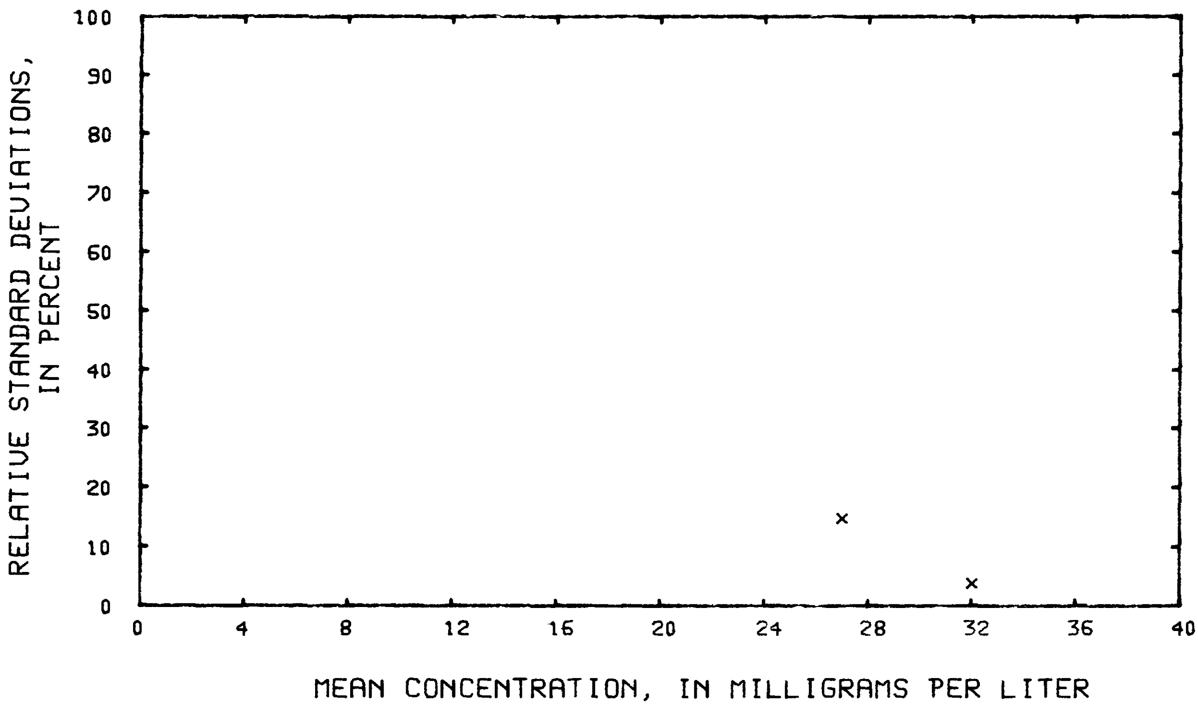


Figure 194.--Precision data for magnesium, dissolved, (atomic absorption spectrometry) at the Denver laboratory.

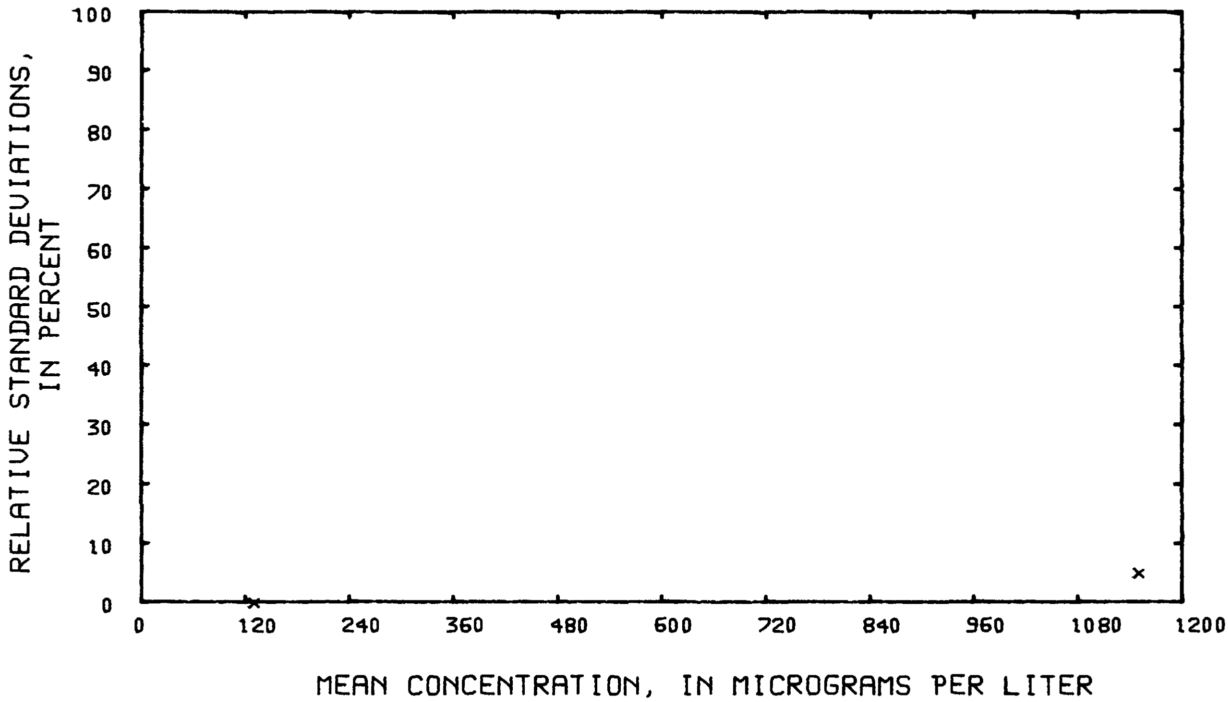


Figure 195.--Precision data for manganese, dissolved, (inductively coupled plasma emission spectrometry) at the Atlanta laboratory.

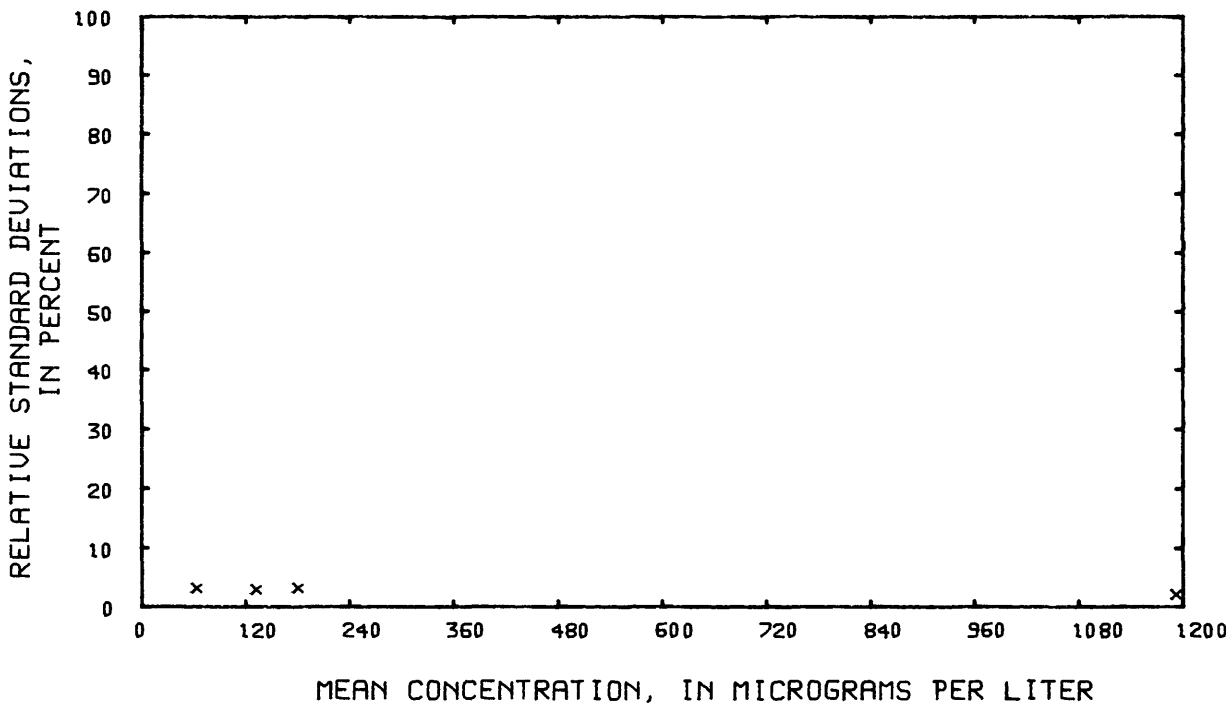


Figure 196.--Precision data for manganese, dissolved, (inductively coupled plasma emission spectrometry) at the Denver laboratory.

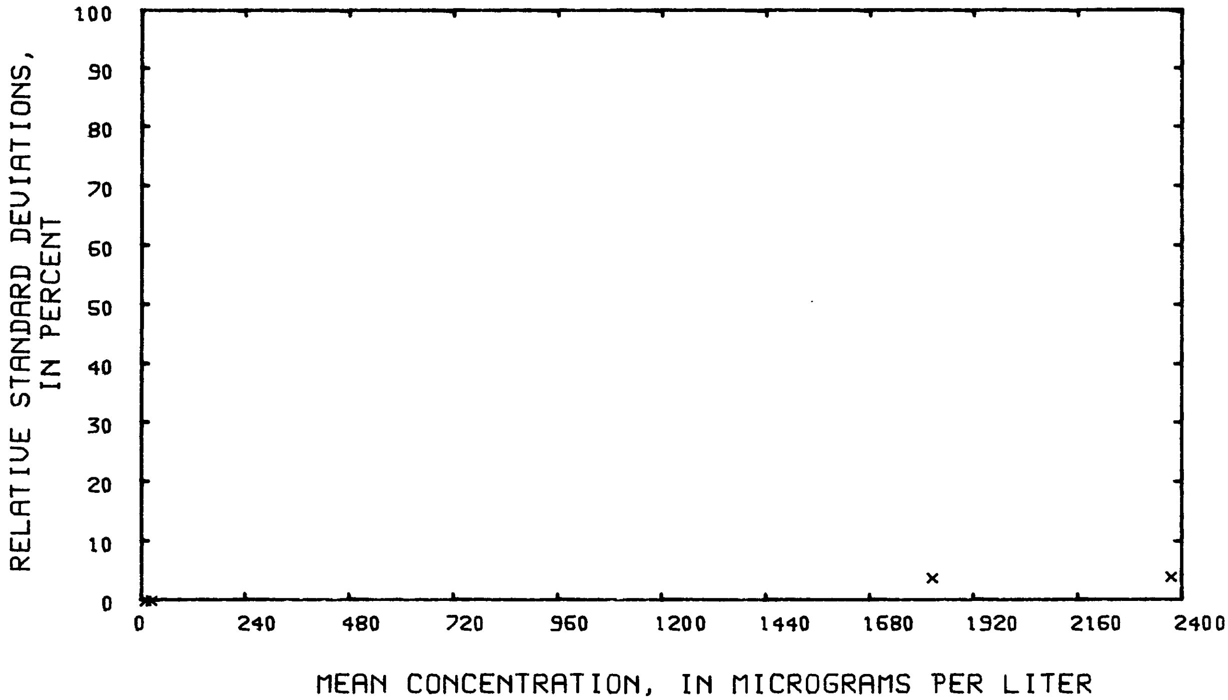


Figure 197.--Precision data for manganese, dissolved, (atomic absorption spectrometry) at the Atlanta laboratory.

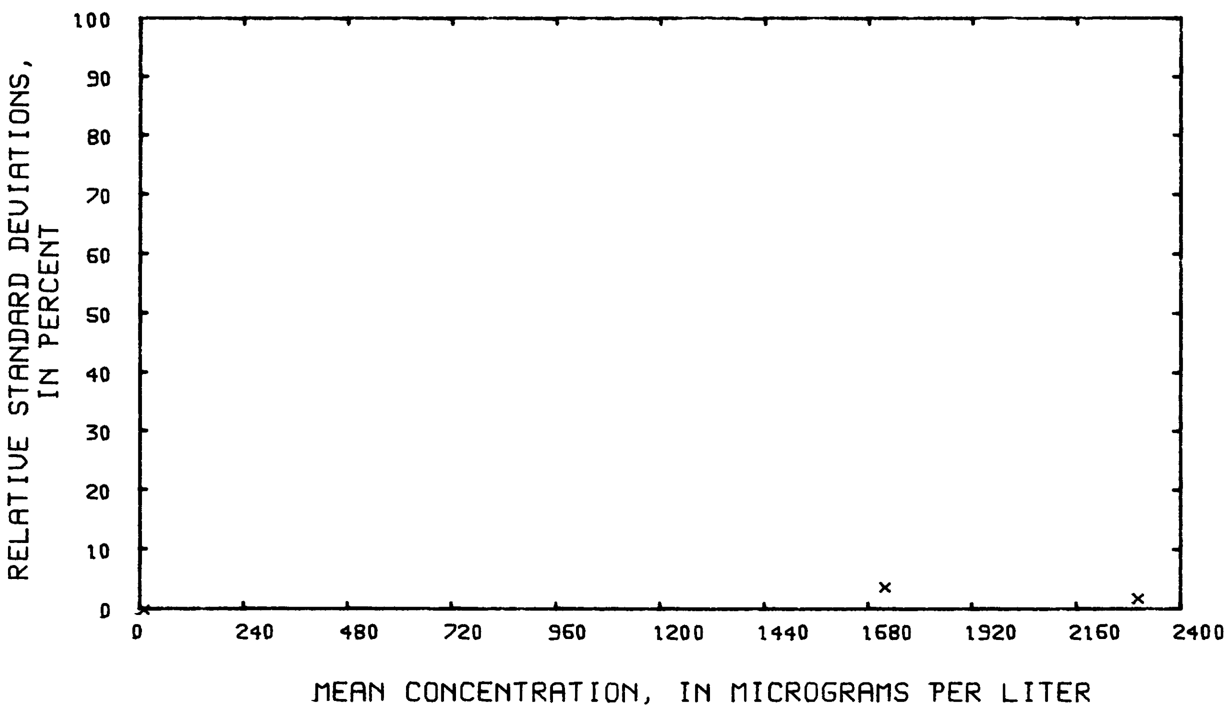


Figure 198.--Precision data for manganese, dissolved, (atomic absorption spectrometry) at the Denver laboratory.

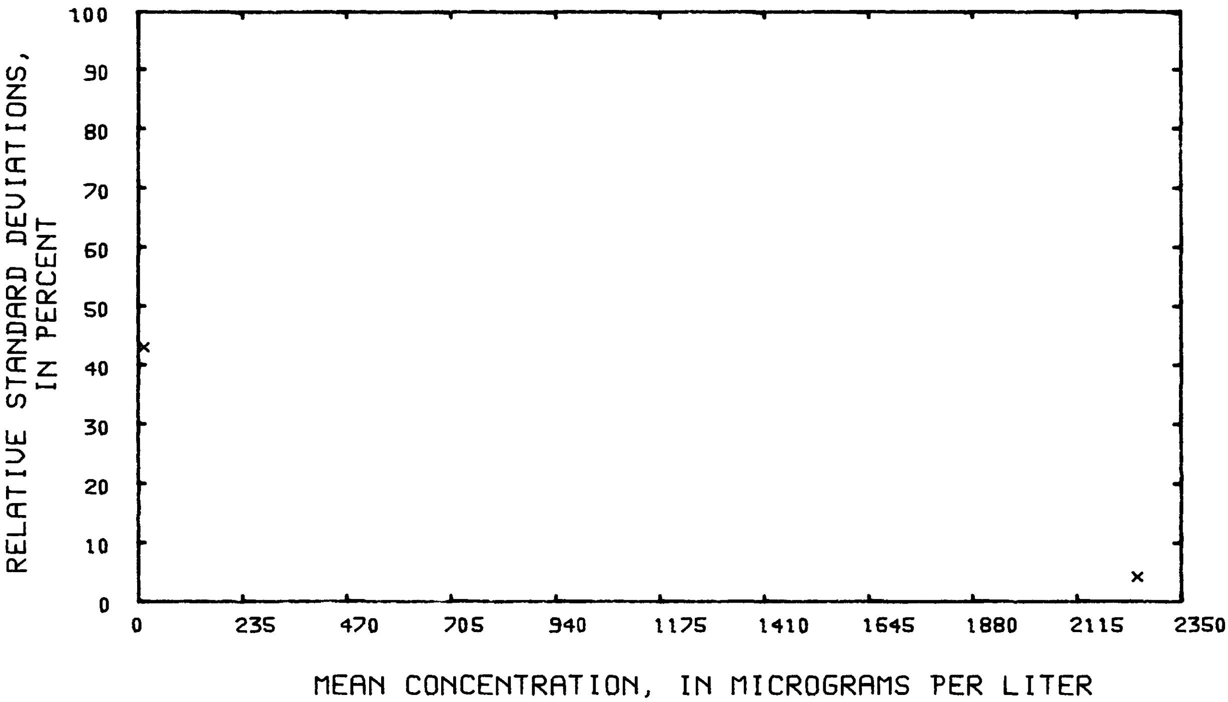


Figure 199.--Precision data for manganese, total recoverable, at the Atlanta laboratory.

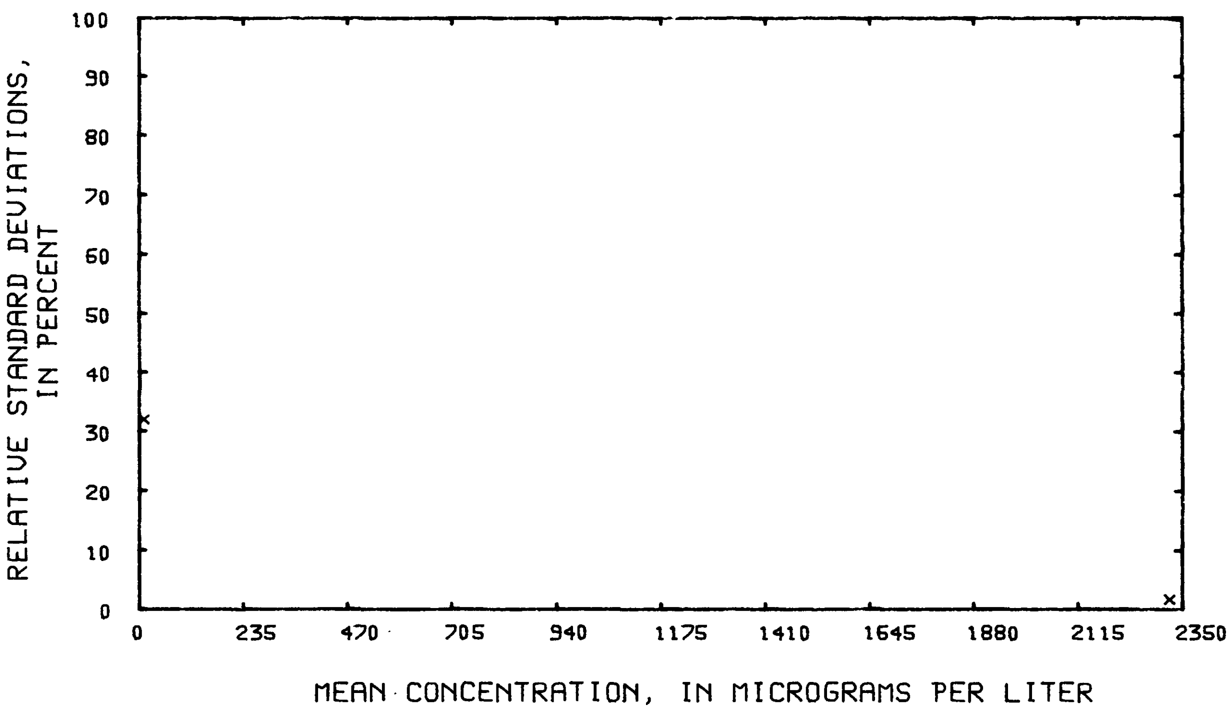


Figure 200.--Precision data for manganese, total recoverable, at the Denver laboratory.

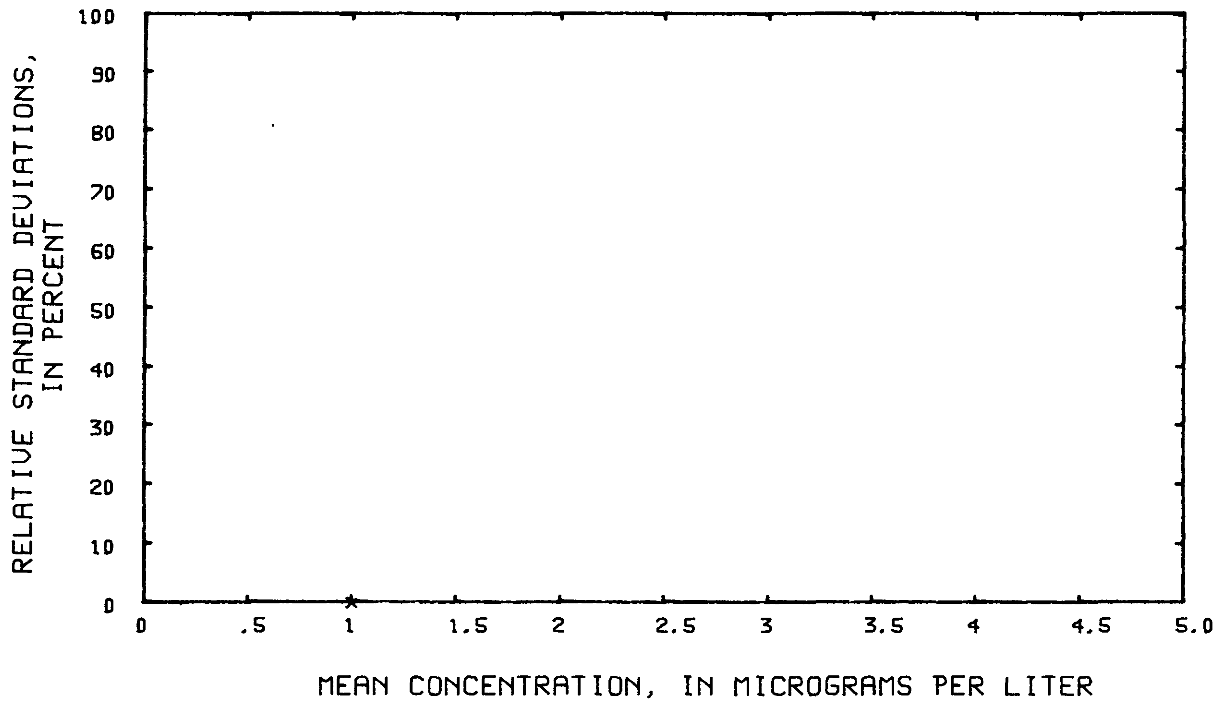


Figure 201.--Precision data for molybdenum, dissolved, (inductively coupled plasma emission spectrometry) at the Atlanta laboratory.

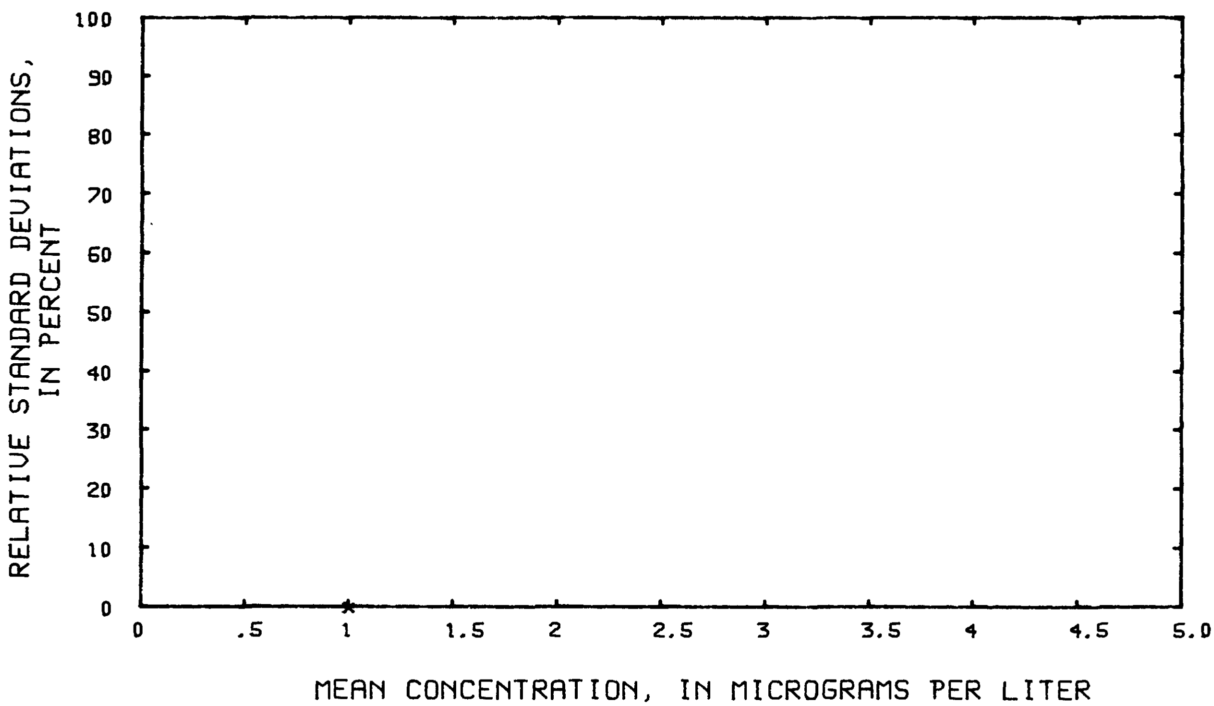


Figure 202.--Precision data for molybdenum, dissolved, (inductively coupled plasma emission spectrometry) at the Denver laboratory.

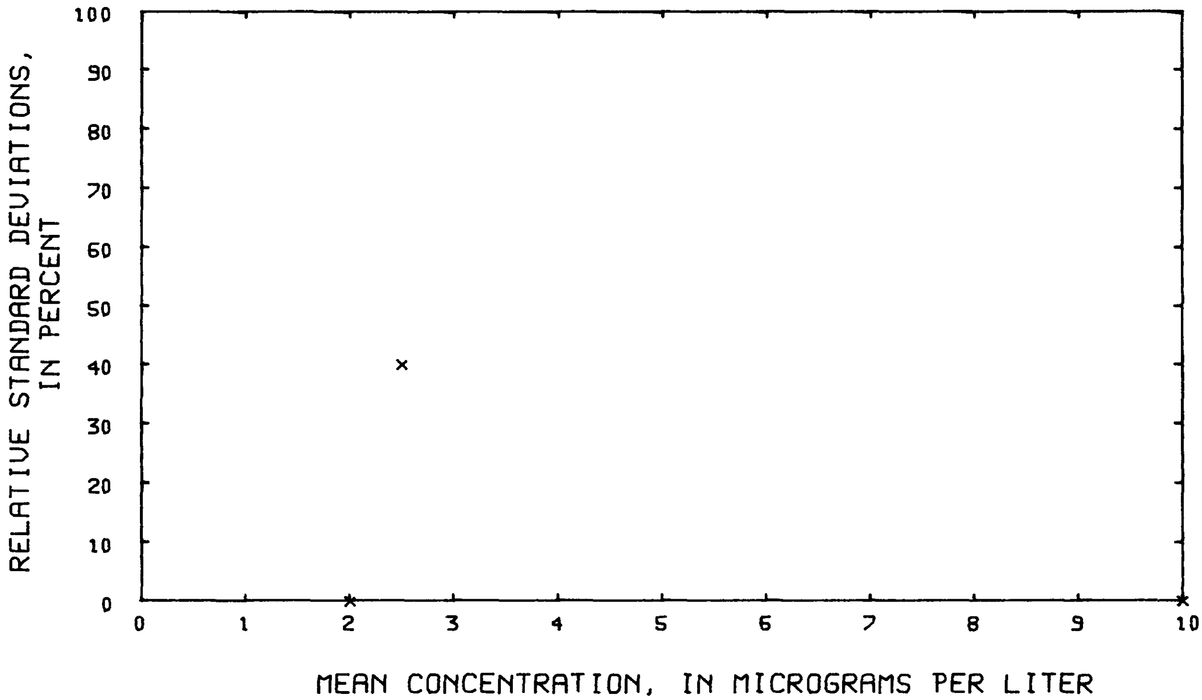


Figure 203.--Precision data for molybdenum, dissolved, (atomic absorption spectrometry) at the Atlanta laboratory.

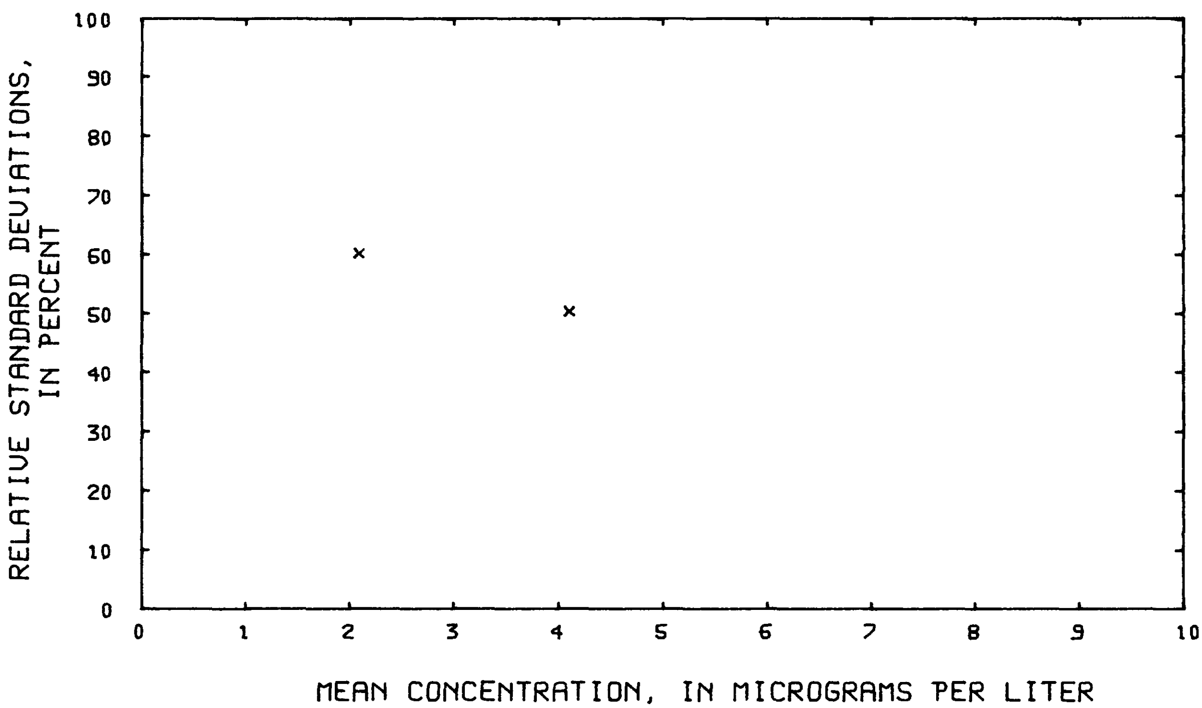


Figure 204.--Precision data for molybdenum, dissolved, (atomic absorption spectrometry) at the Denver laboratory.

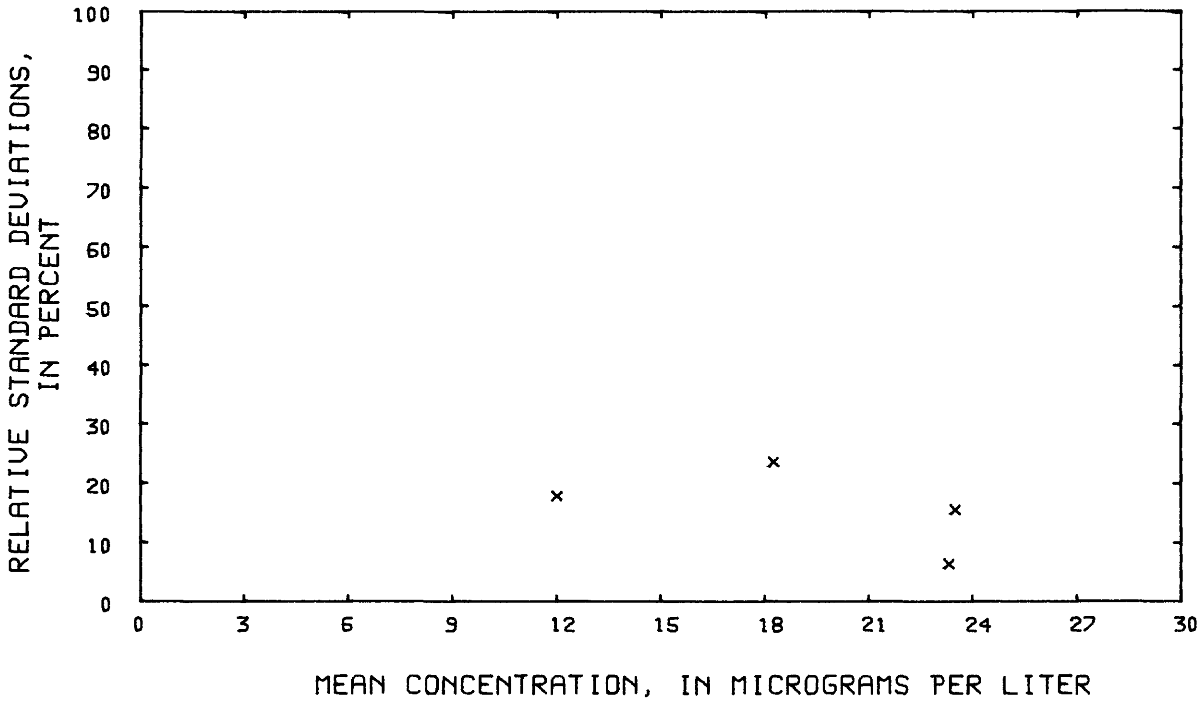


Figure 205.--Precision data for nickel, dissolved, at the Atlanta laboratory.

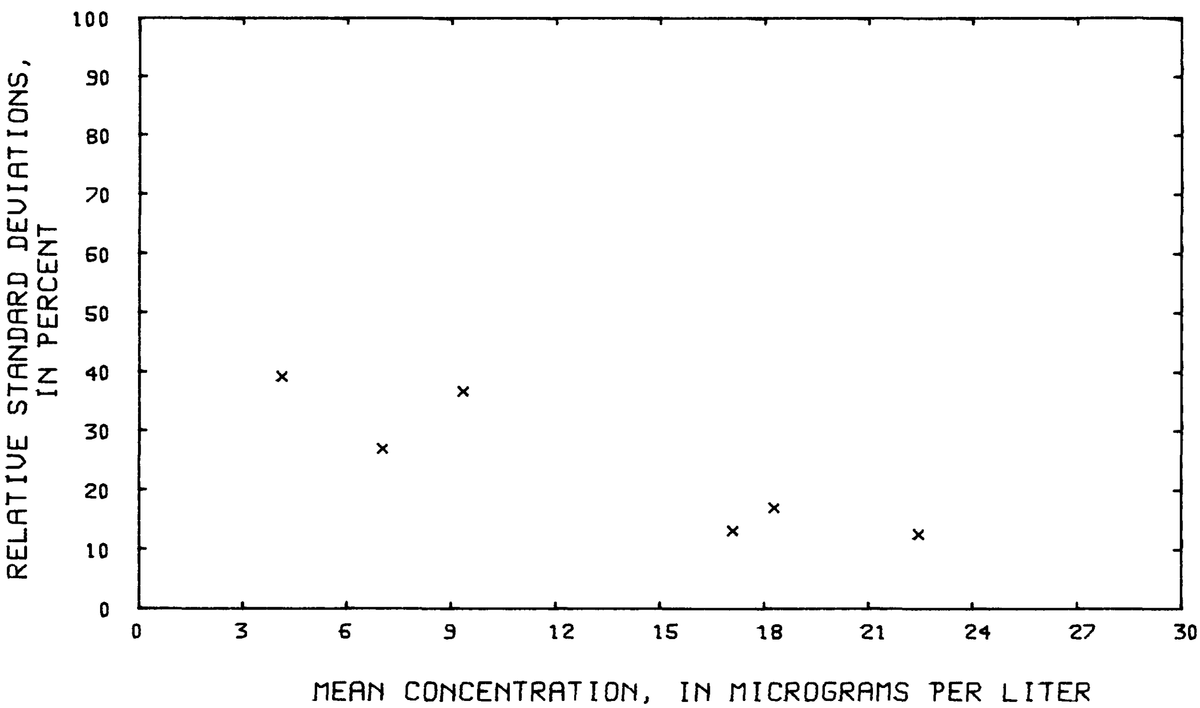


Figure 206.--Precision data for nickel, dissolved, at the Denver laboratory.

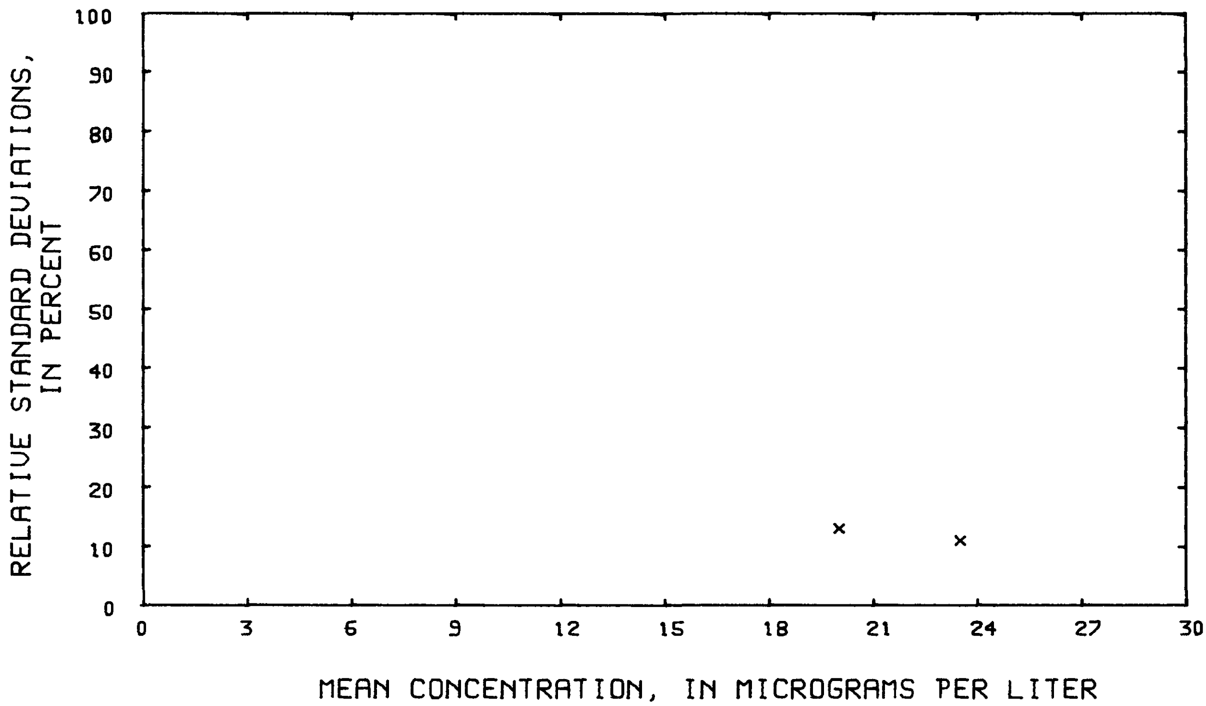


Figure 207.--Precision data for nickel, total recoverable, at the Atlanta laboratory.

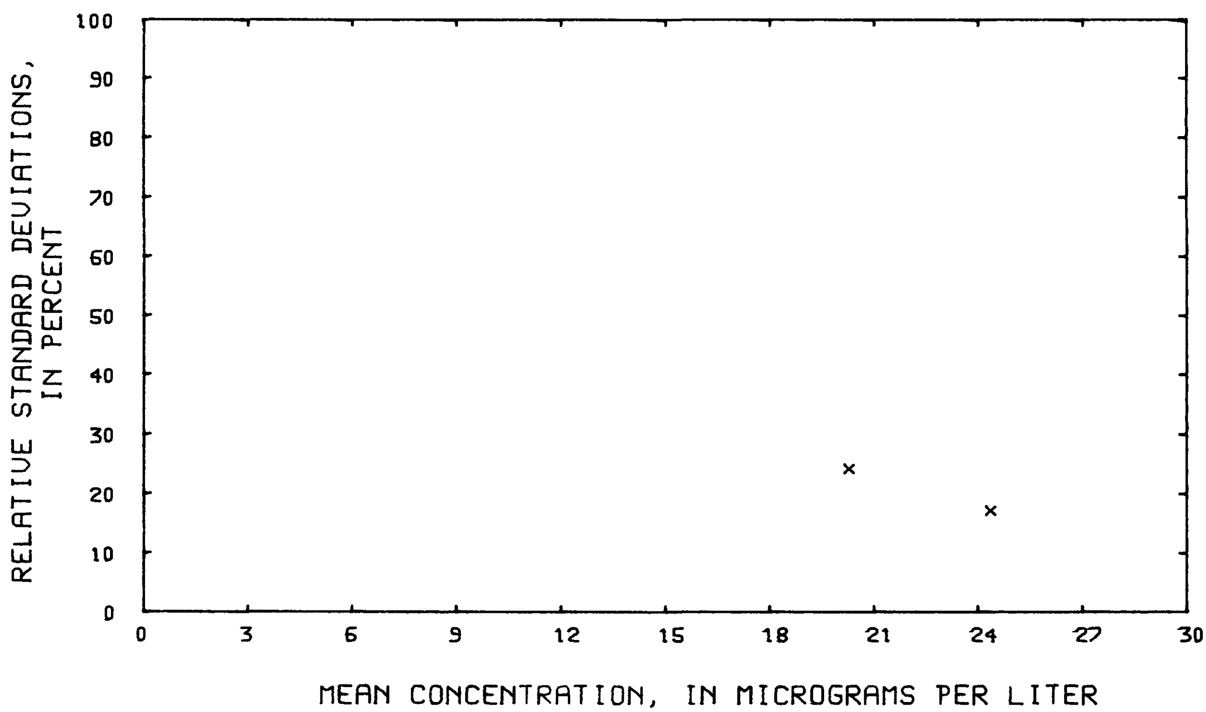


Figure 208.--Precision data for nickel, total recoverable, at the Denver laboratory.

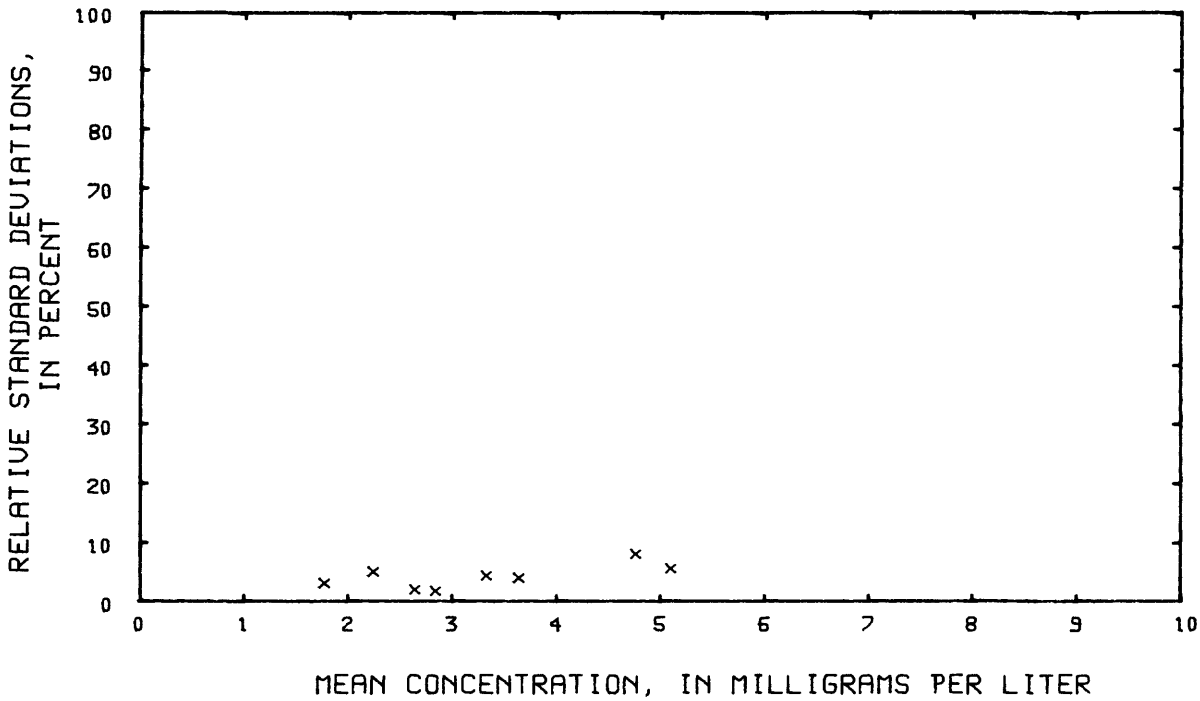


Figure 209.--Precision data for potassium, dissolved, at the Atlanta laboratory.

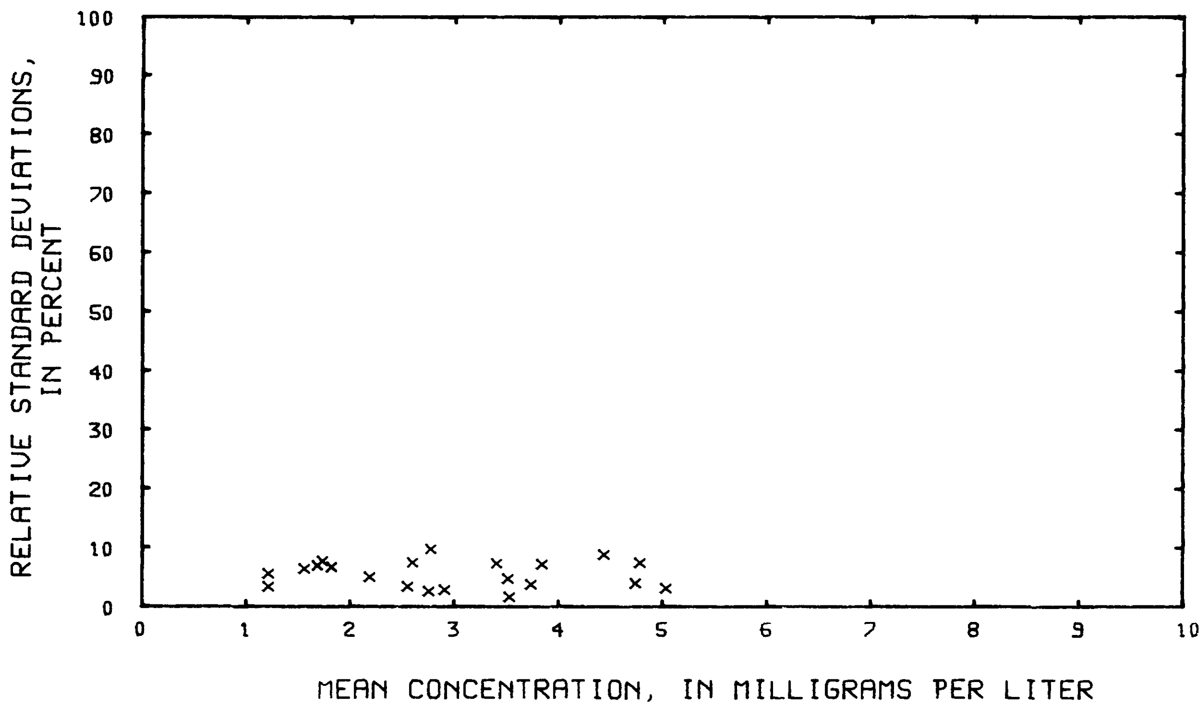


Figure 210.--Precision data for potassium, dissolved, at the Denver laboratory.

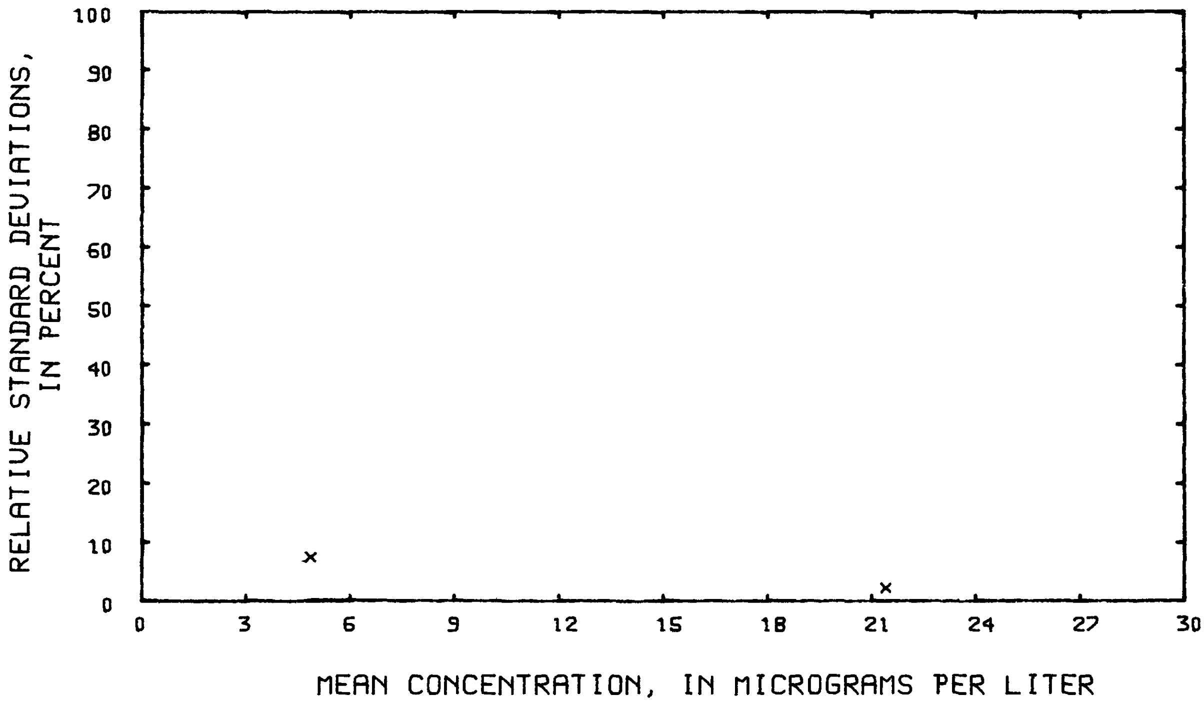


Figure 211.--Precision data for selenium, dissolved, at the Atlanta laboratory.

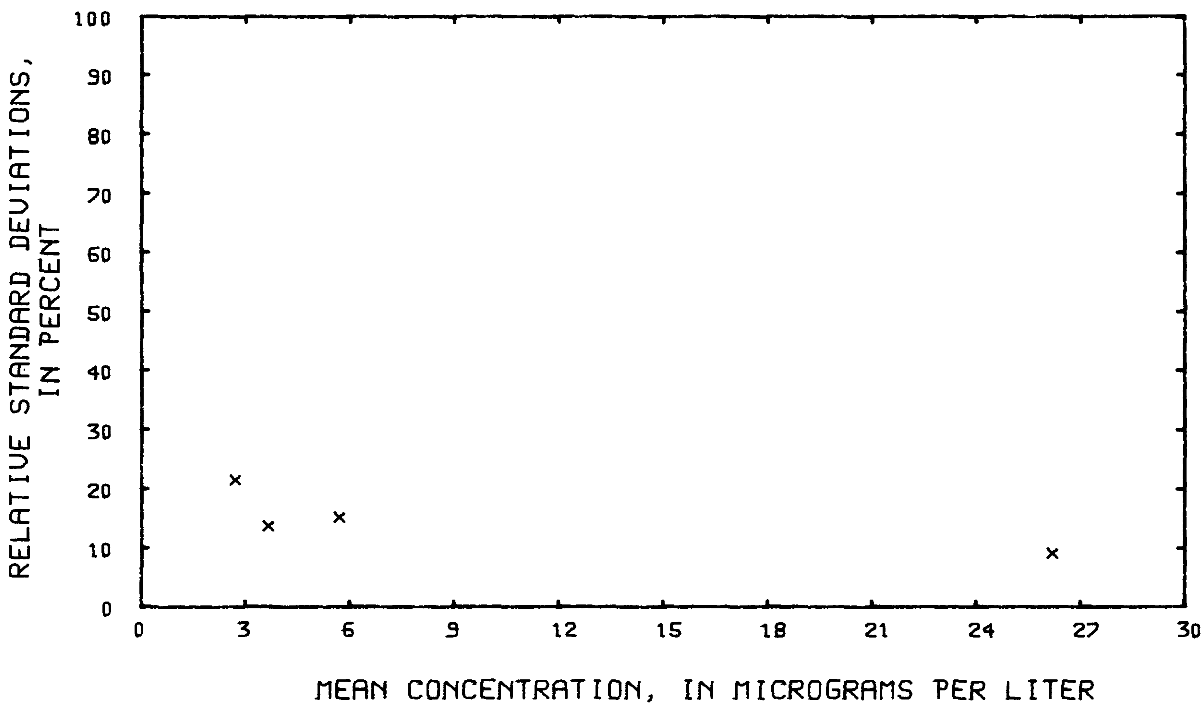


Figure 212.--Precision data for selenium, dissolved, at the Denver laboratory.

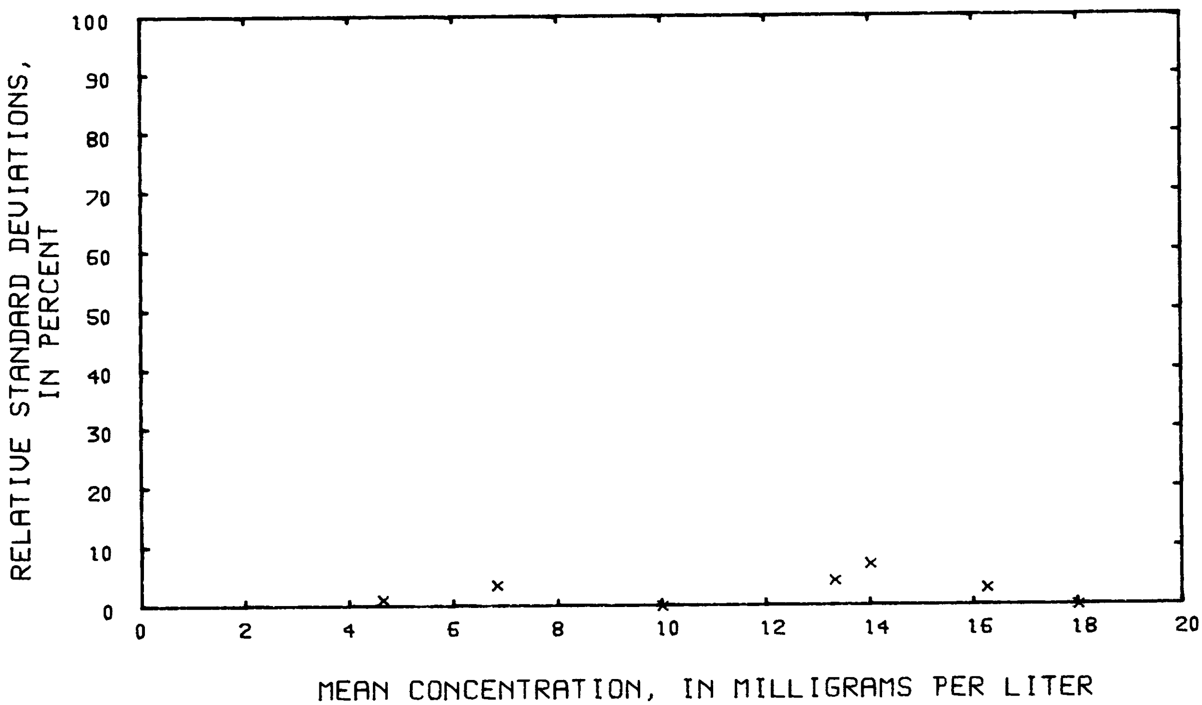


Figure 213.--Precision data for silica, dissolved, at the Atlanta laboratory.

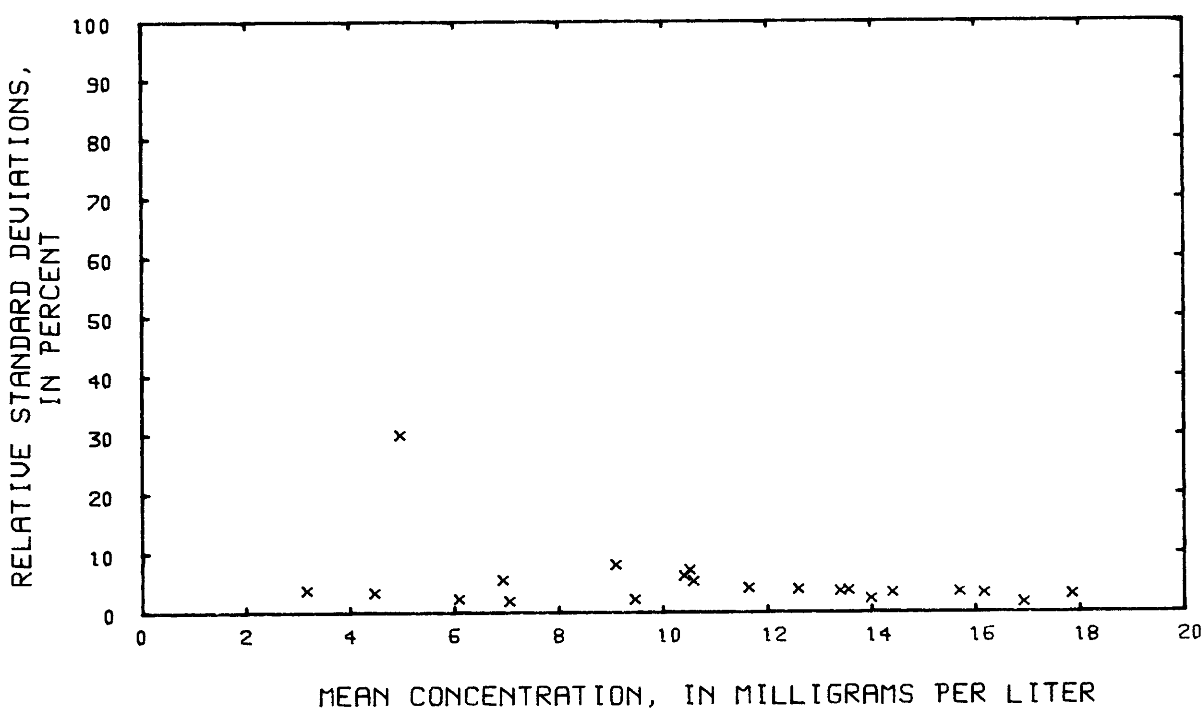


Figure 214.--Precision data for silica, dissolved, at the Denver laboratory.

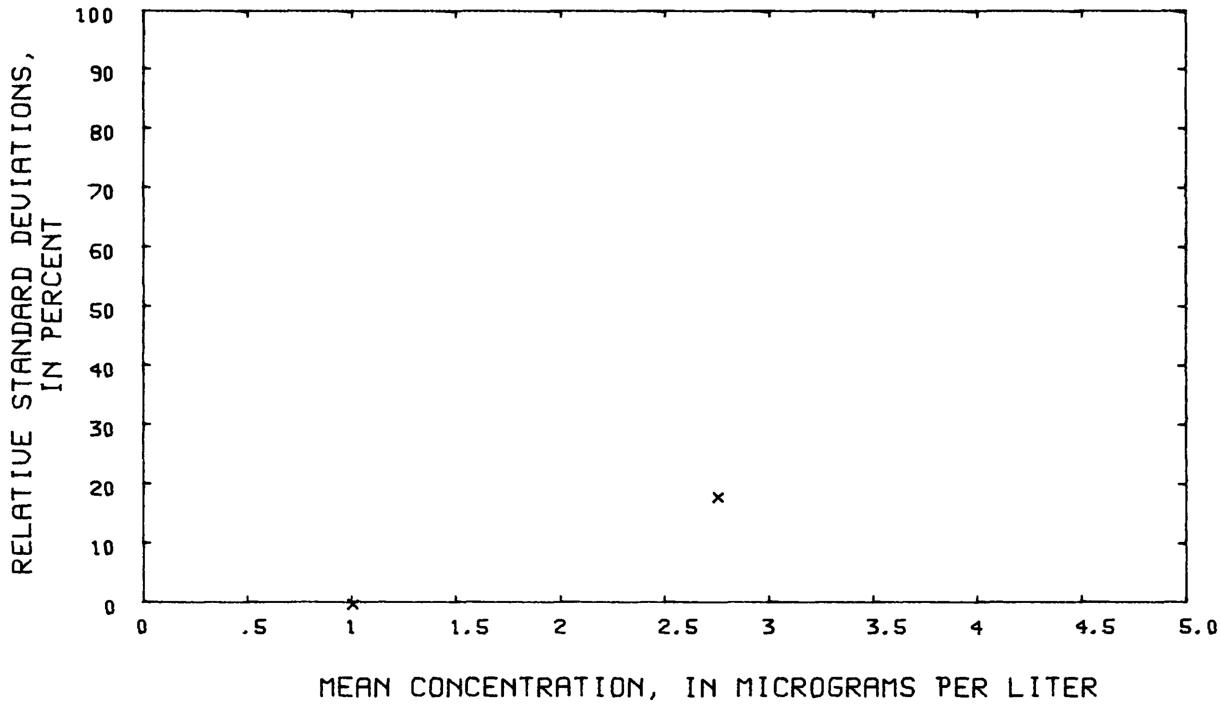


Figure 215.--Precision data for silver, dissolved, at the Atlanta laboratory.

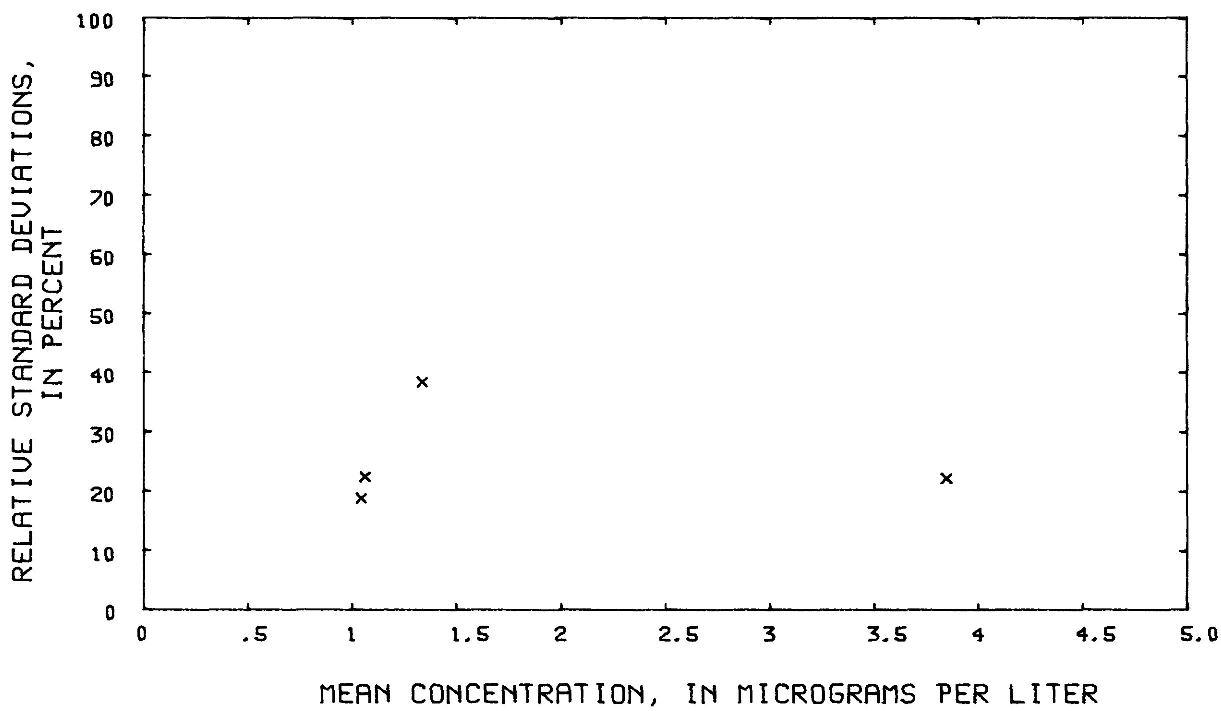


Figure 216.--Precision data for silver, dissolved, at the Denver laboratory.

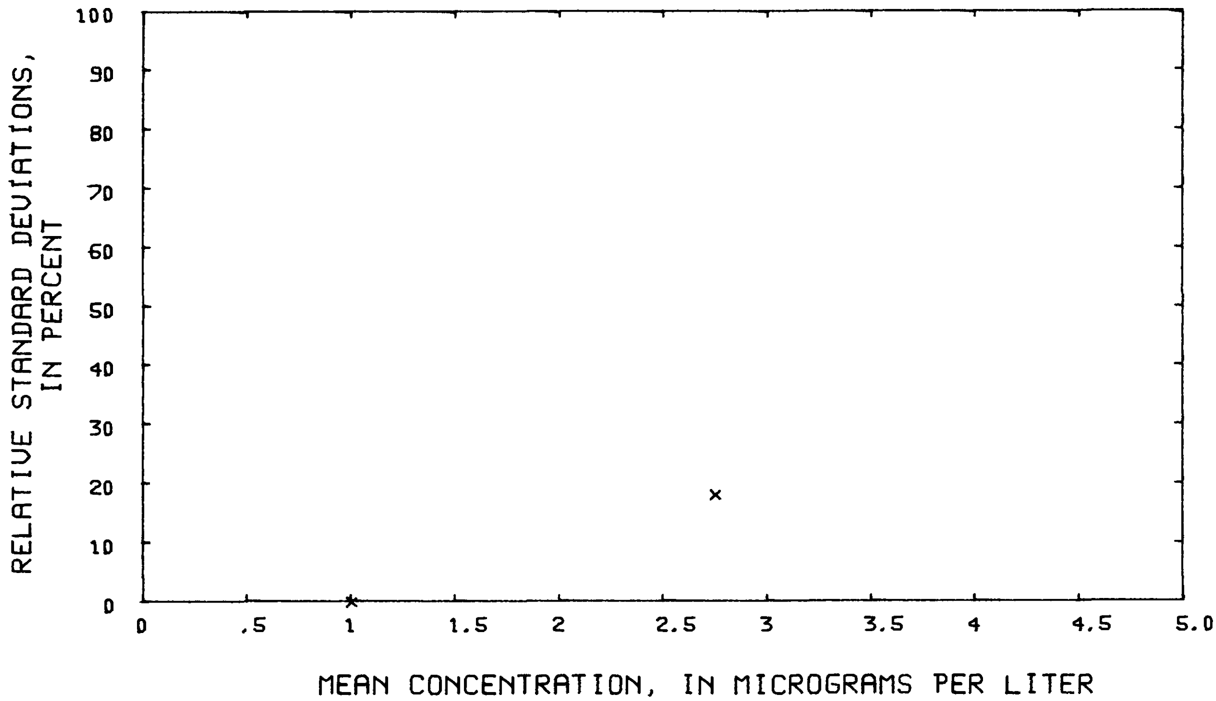


Figure 217.--Precision data for silver, total recoverable, at the Atlanta laboratory.

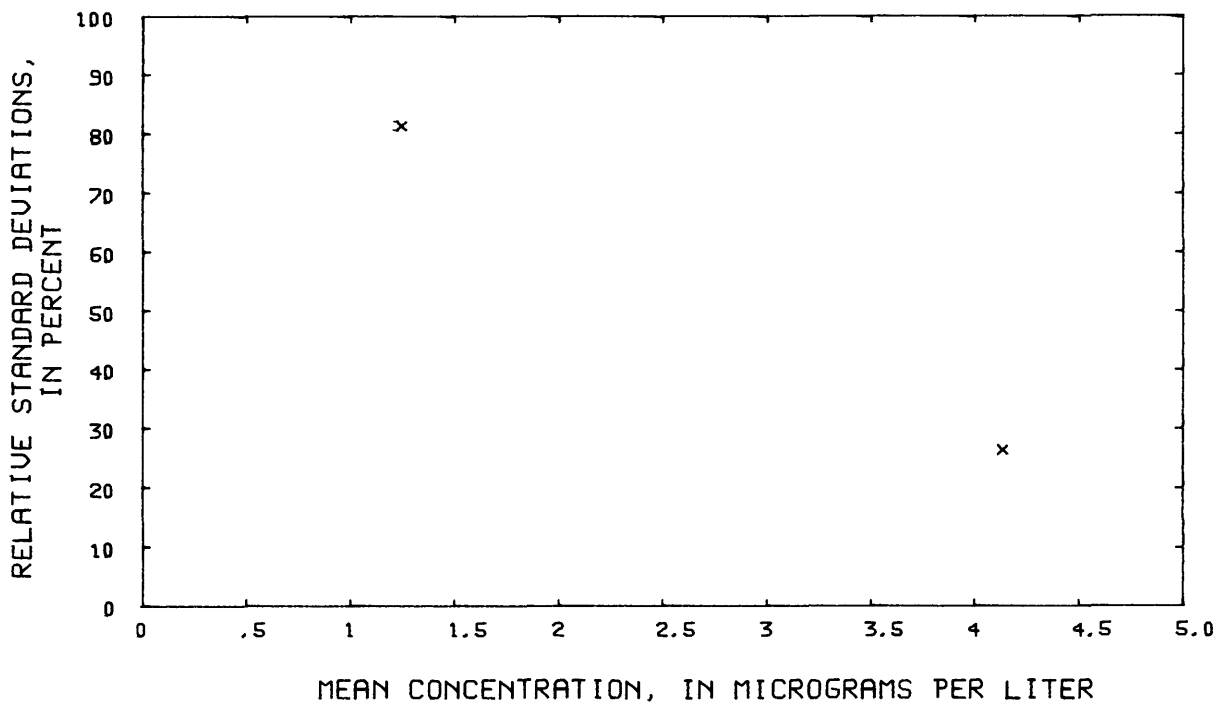


Figure 218.--Precision data for silver, total recoverable, at the Denver laboratory.

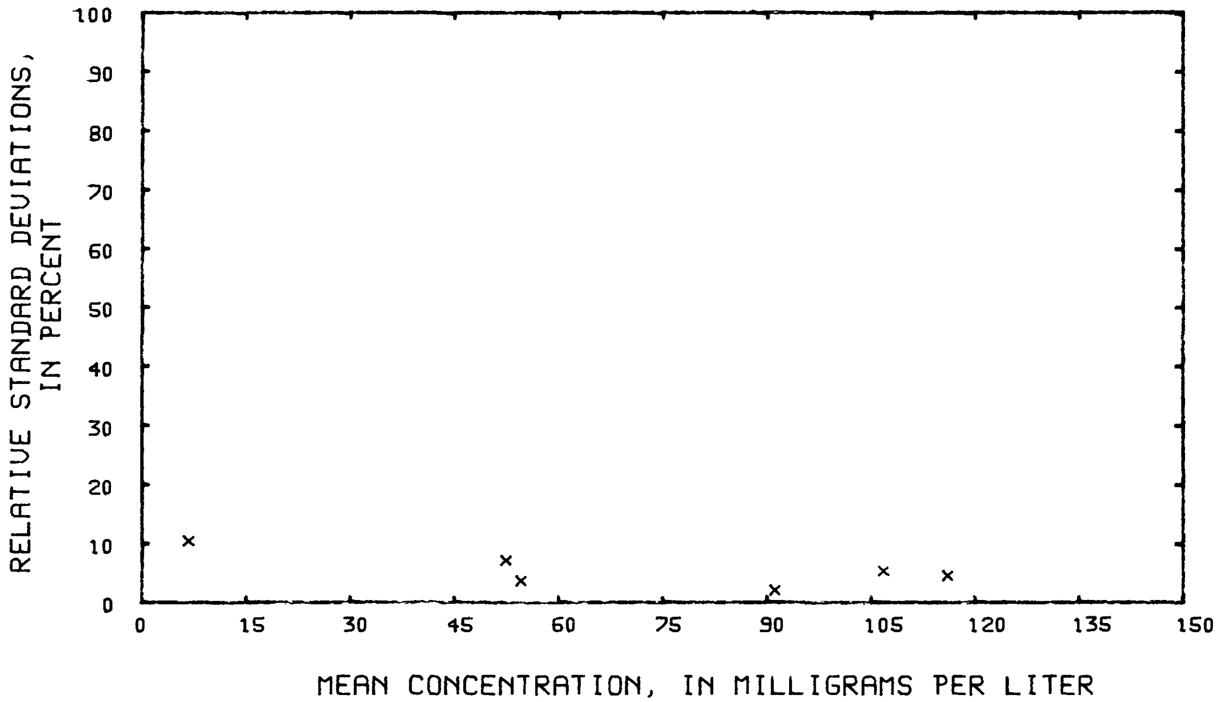


Figure 219.--Precision data for sodium, dissolved, (inductively coupled plasma emission spectrometry) at the Atlanta laboratory.

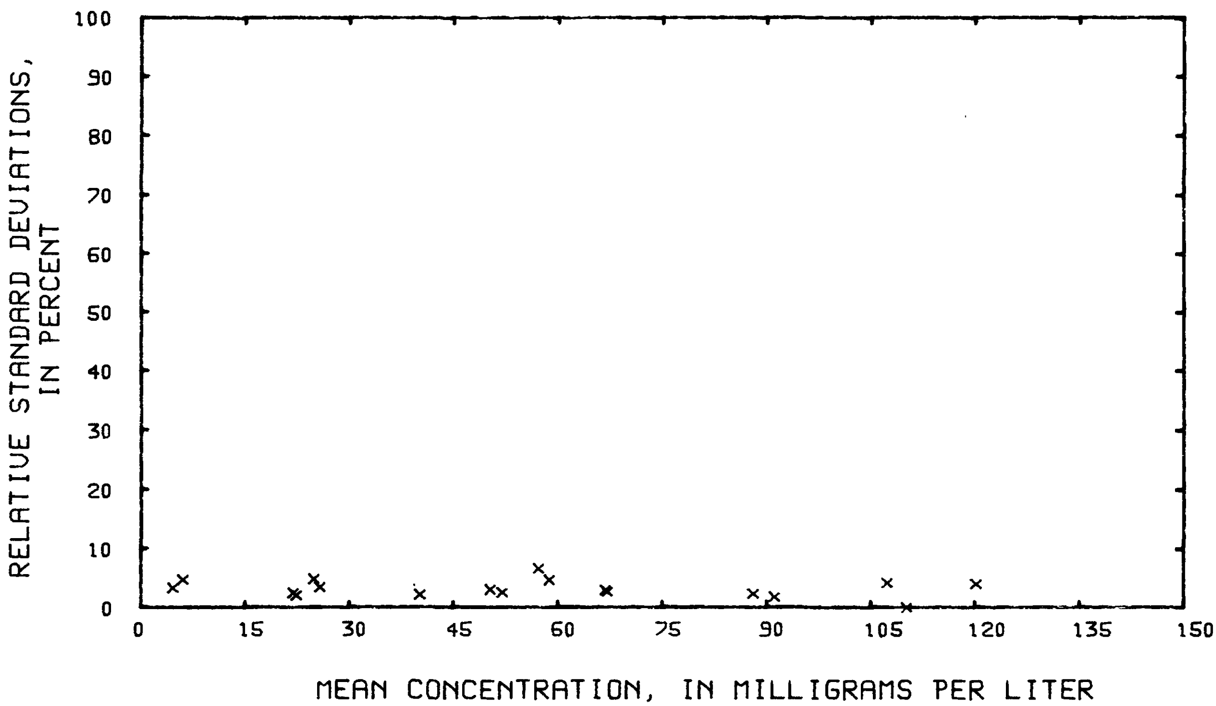


Figure 220.--Precision data for sodium, dissolved, (inductively coupled plasma emission spectrometry) at the Denver laboratory.

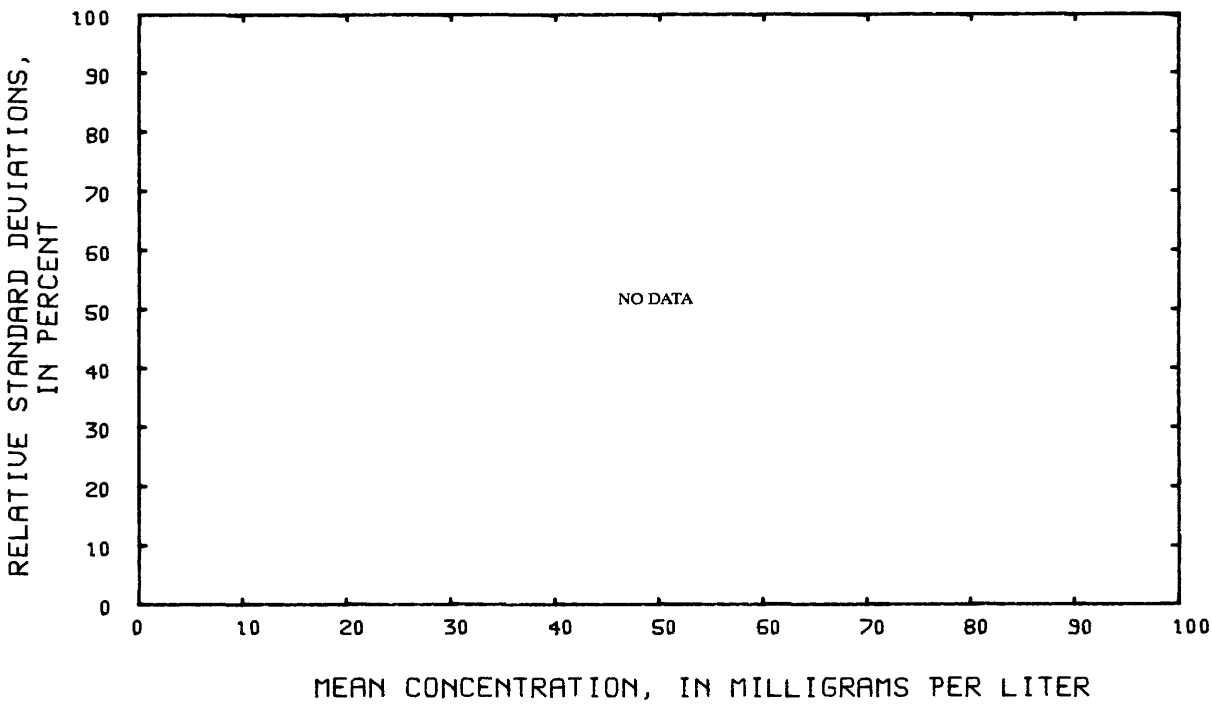


Figure 221.--Precision data for sodium, dissolved, (atomic absorption spectrometry) at the Atlanta laboratory.

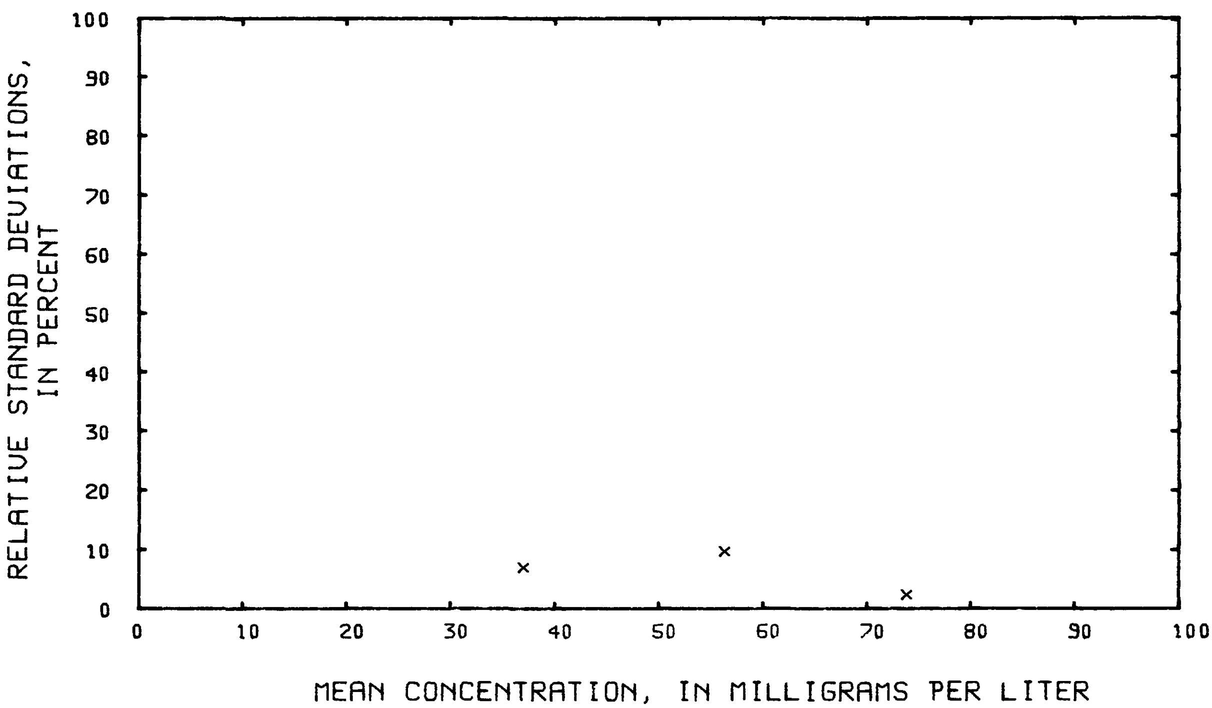


Figure 222.--Precision data for sodium, dissolved, (atomic absorption spectrometry) at the Denver laboratory.

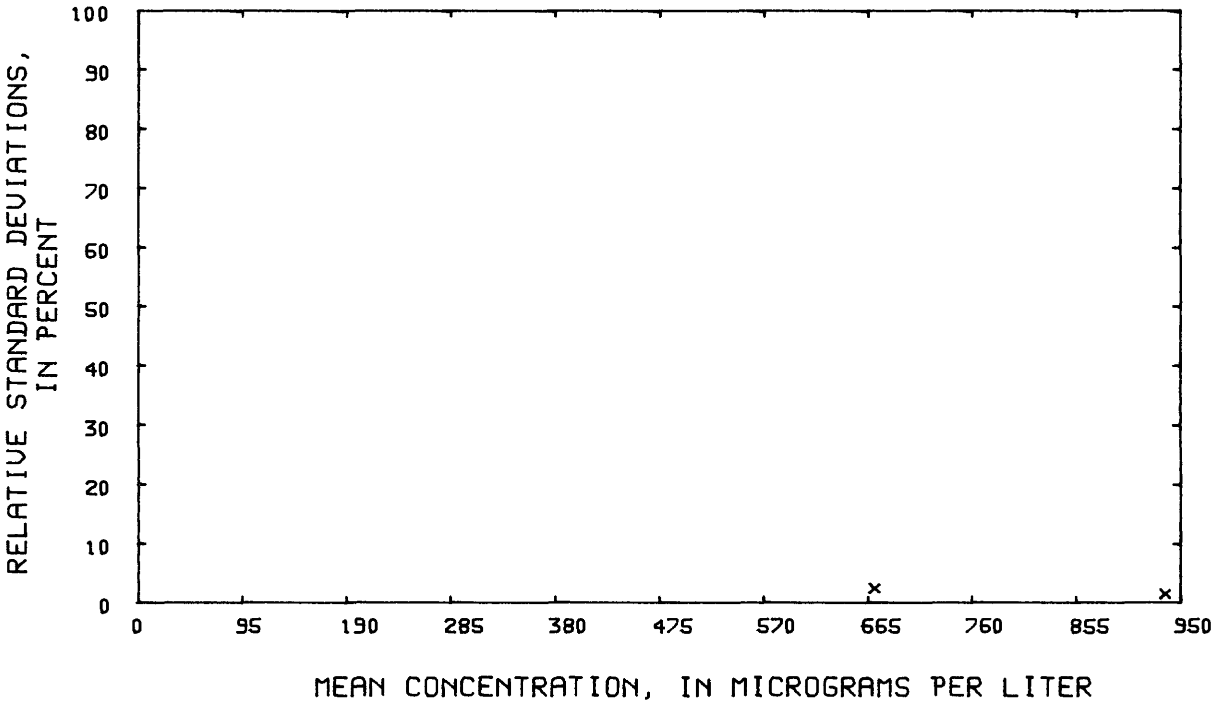


Figure 223.--Precision data for strontium, dissolved, at the Atlanta laboratory.

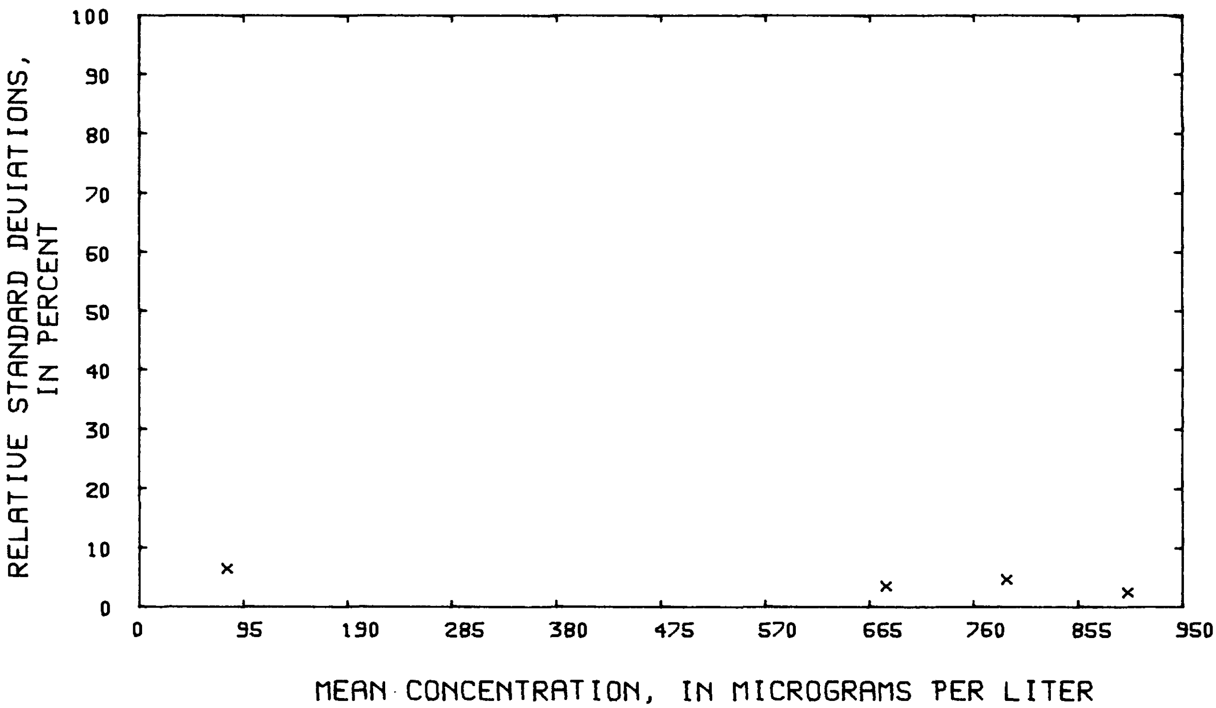


Figure 224.--Precision data for strontium, dissolved, at the Denver laboratory.

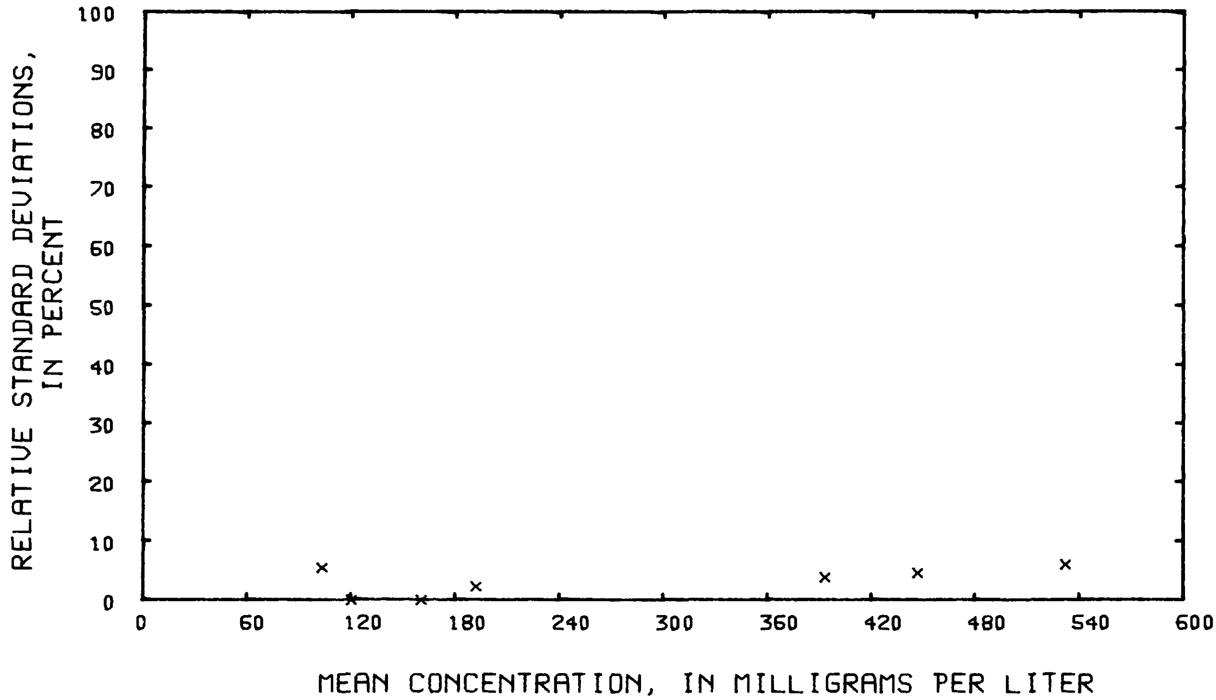


Figure 225.--Precision data for sulfate, dissolved, at the Atlanta laboratory.

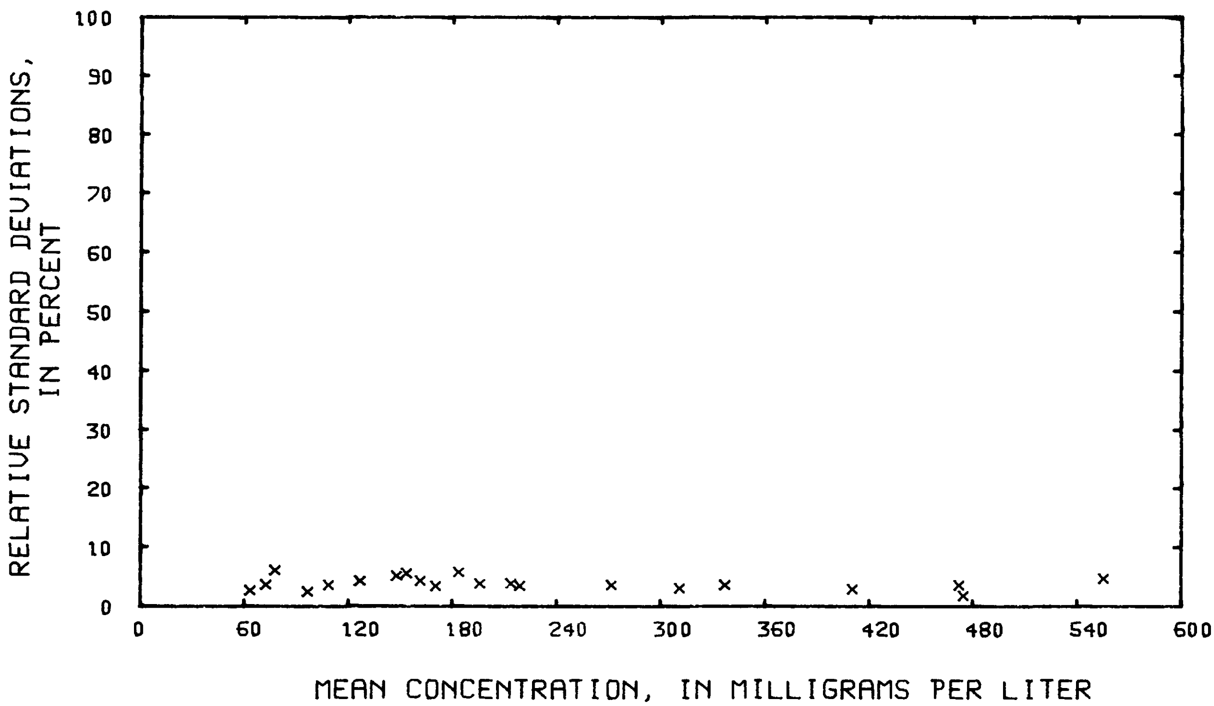


Figure 226.--Precision data for sulfate, dissolved, at the Denver laboratory.

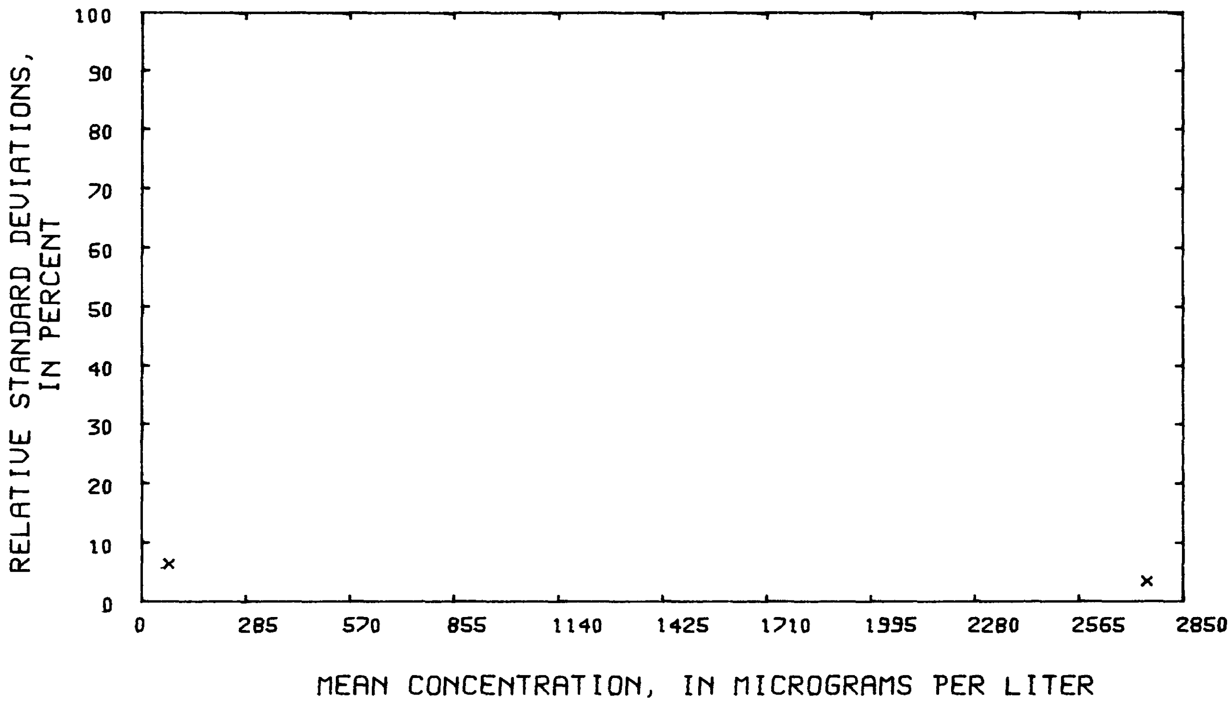


Figure 227.--Precision data for zinc, dissolved, (inductively coupled plasma emission spectrometry) at the Atlanta laboratory.

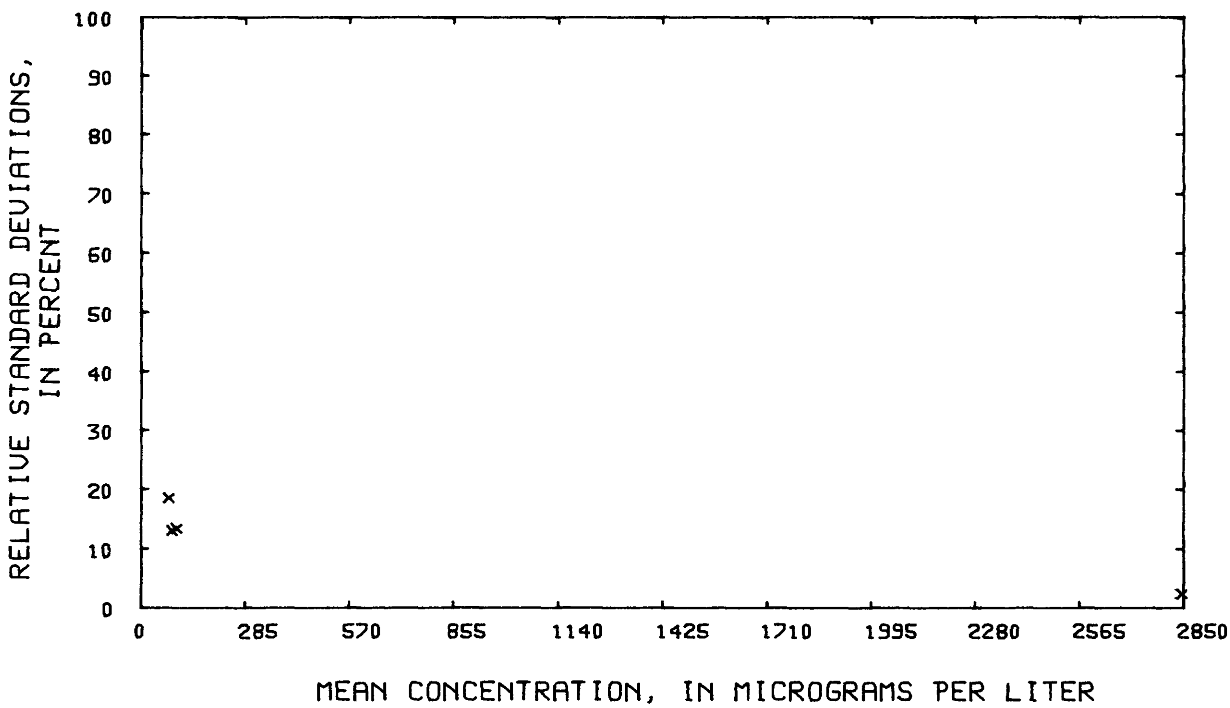


Figure 228.--Precision data for zinc, dissolved, (inductively coupled plasma emission spectrometry) at the Denver laboratory.

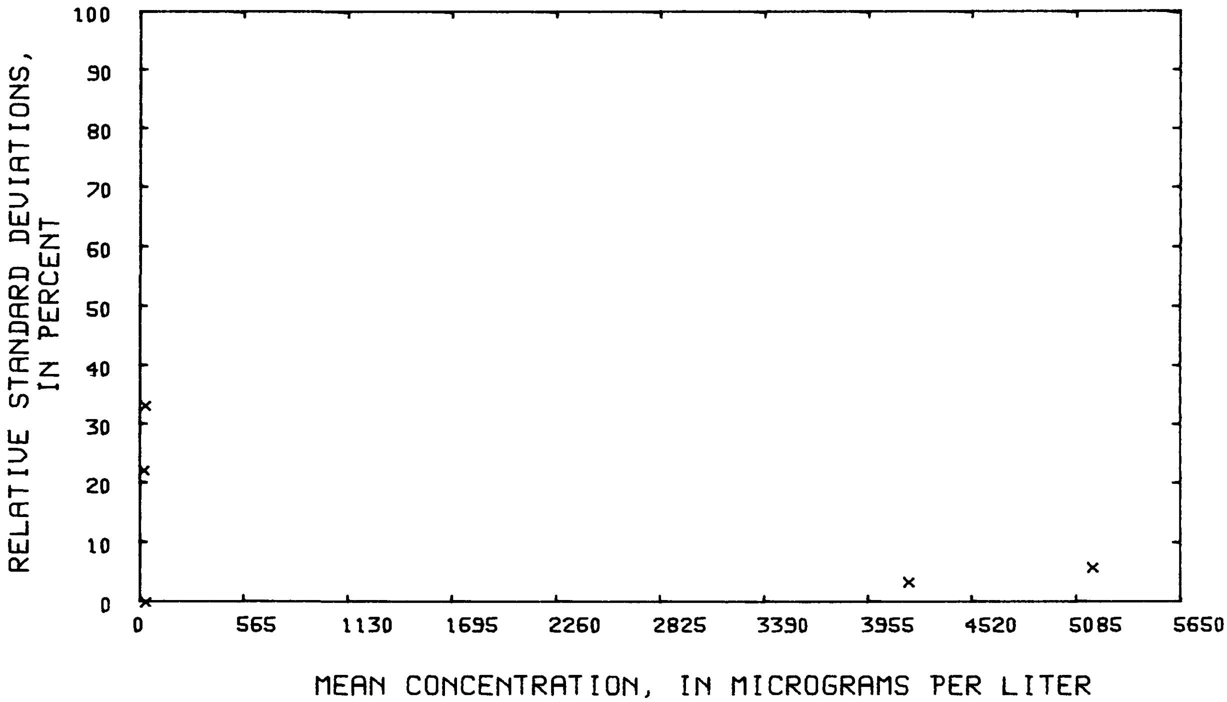


Figure 229.--Precision data for zinc, dissolved, (atomic absorption spectrometry) at the Atlanta laboratory.

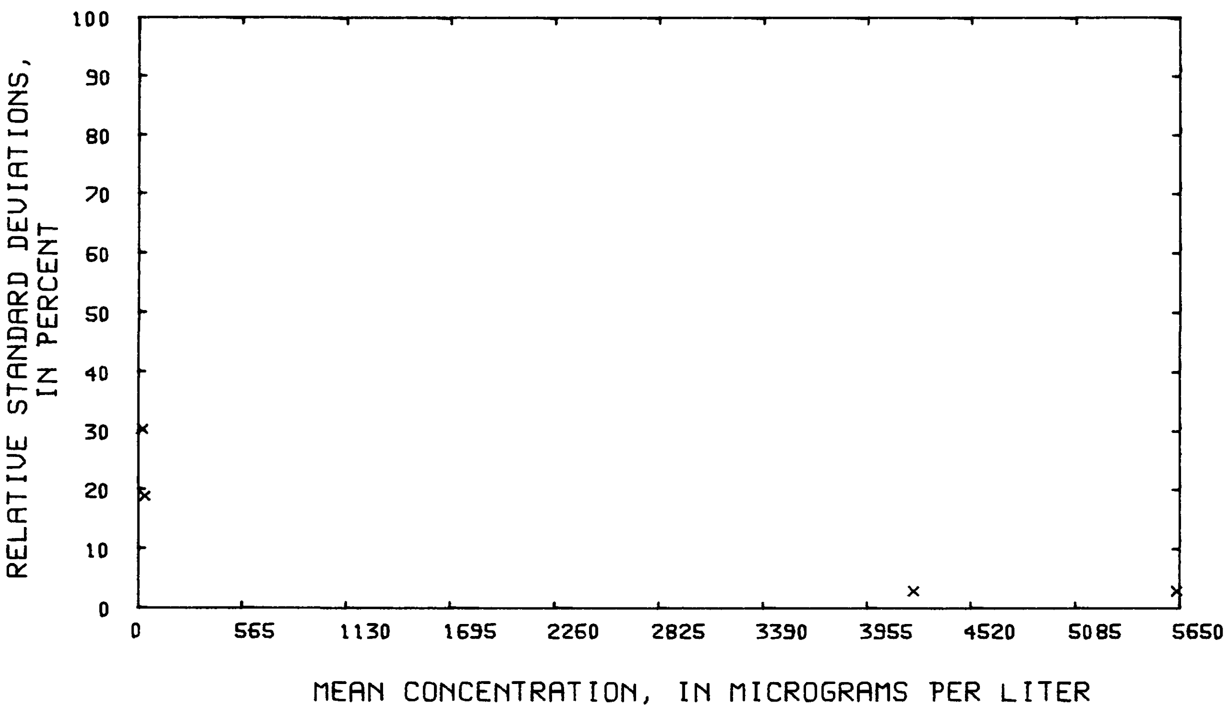


Figure 230.--Precision data for zinc, dissolved, (atomic absorption spectrometry) at the Denver laboratory.

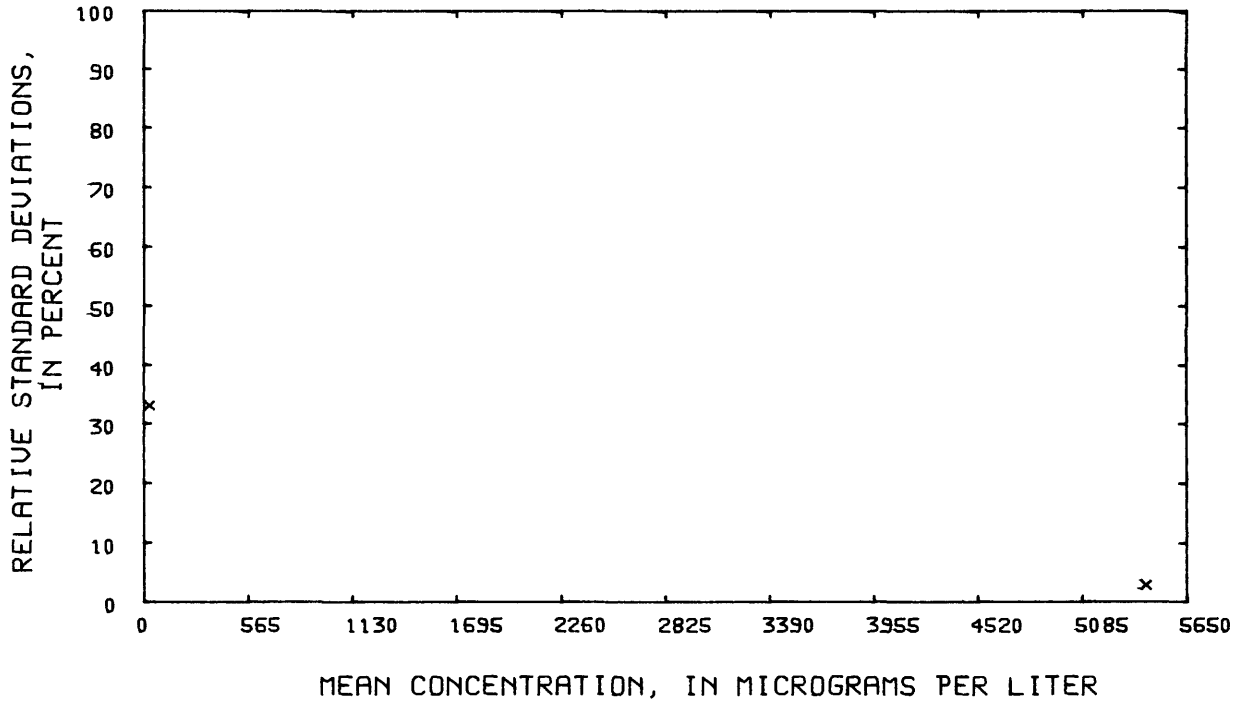


Figure 231.--Precision data for zinc, total recoverable, at the Atlanta laboratory.

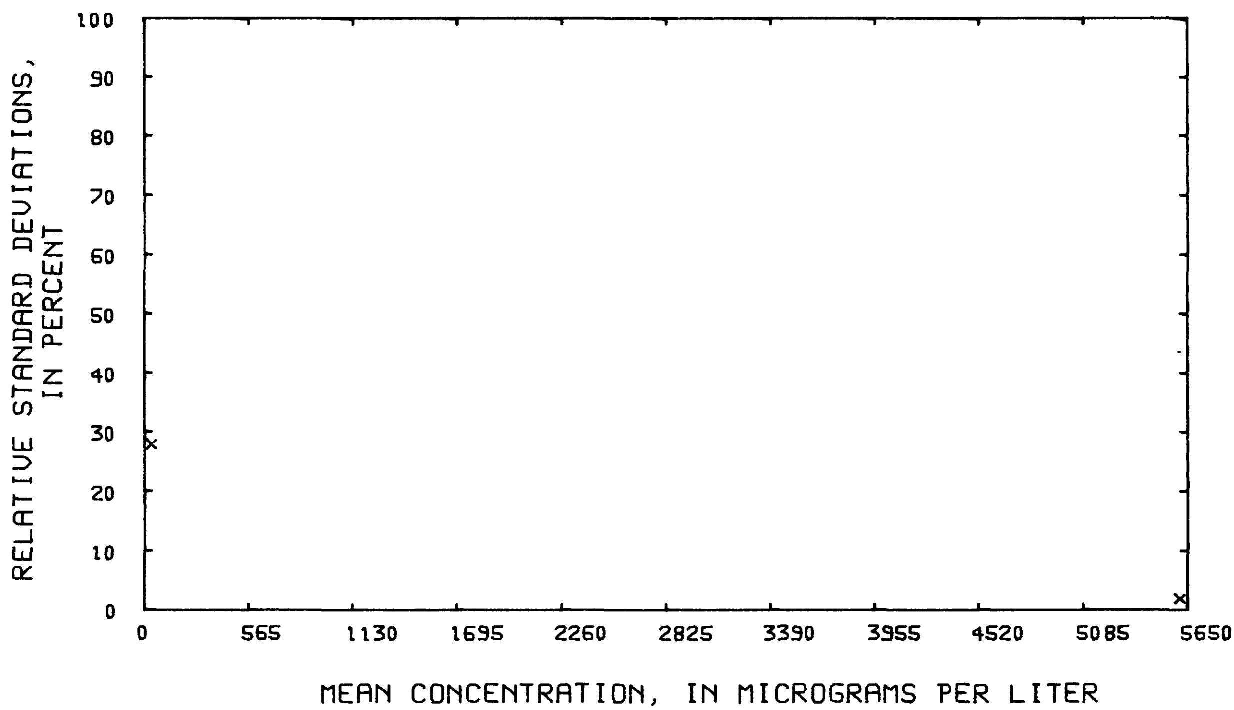


Figure 232.--Precision data for zinc, total recoverable, at the Denver laboratory.

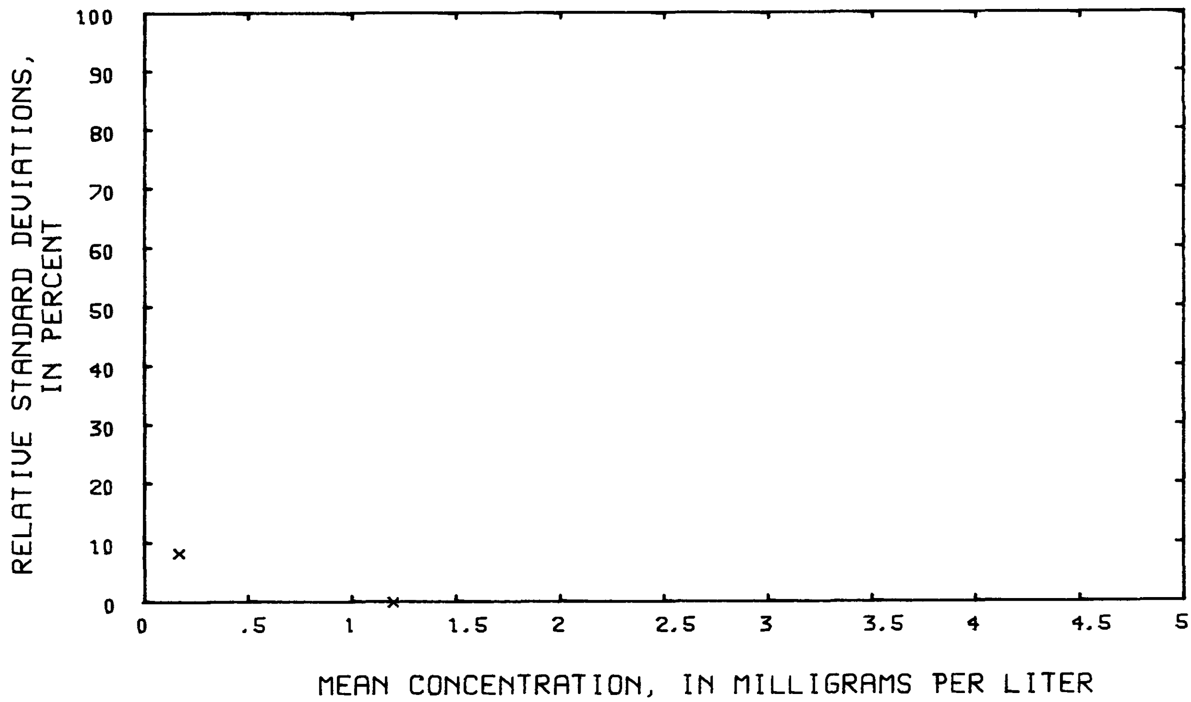


Figure 233.--Precision data for ammonia nitrogen as N, dissolved, at the Atlanta laboratory.

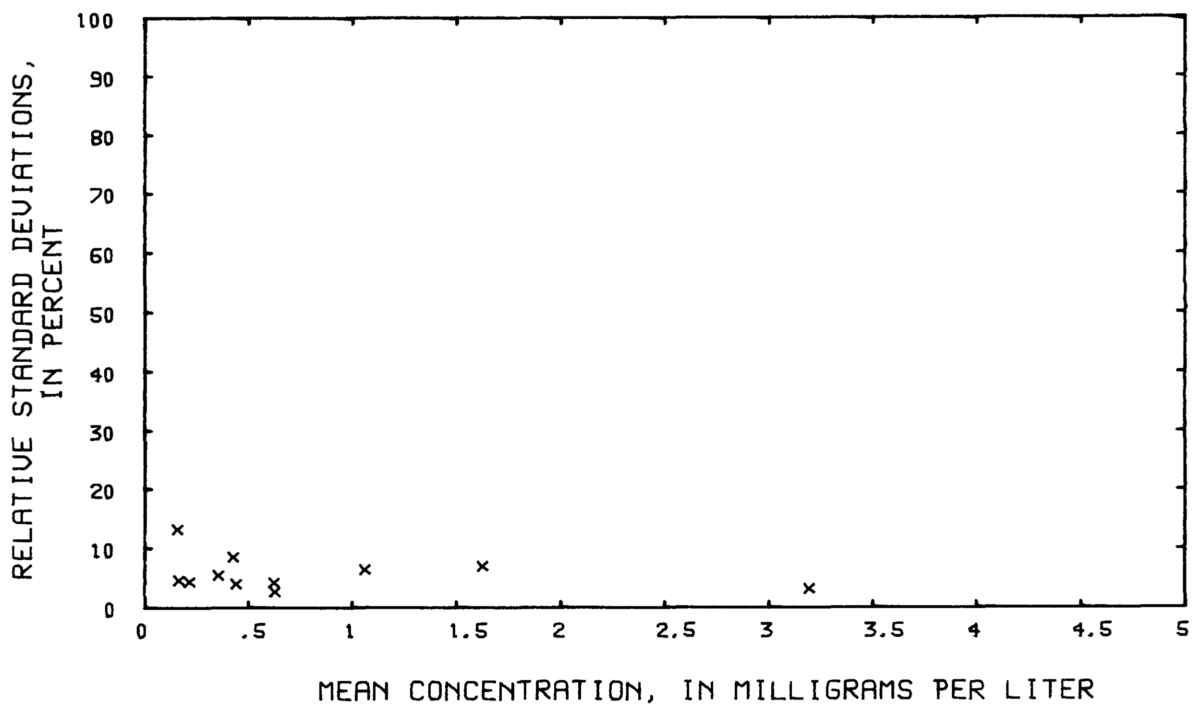


Figure 234.--Precision data for ammonia nitrogen as N, dissolved, at the Denver laboratory.

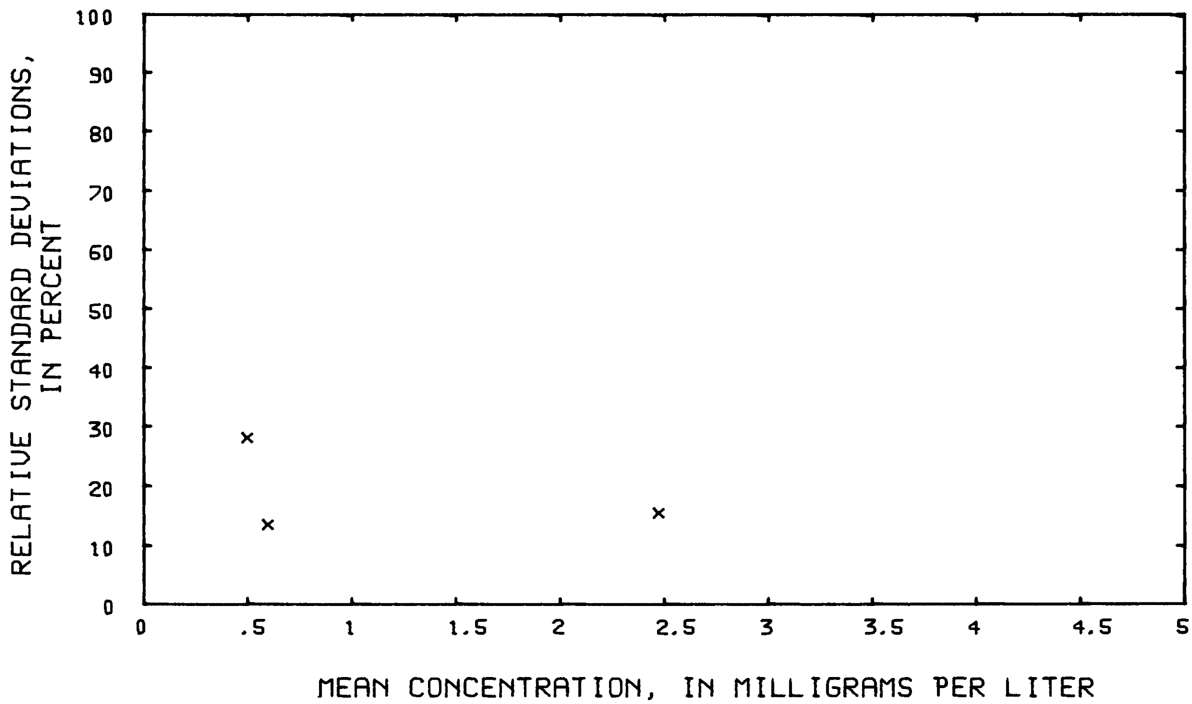


Figure 235.--Precision data for ammonia + organic nitrogen as N, dissolved, at the Atlanta laboratory.

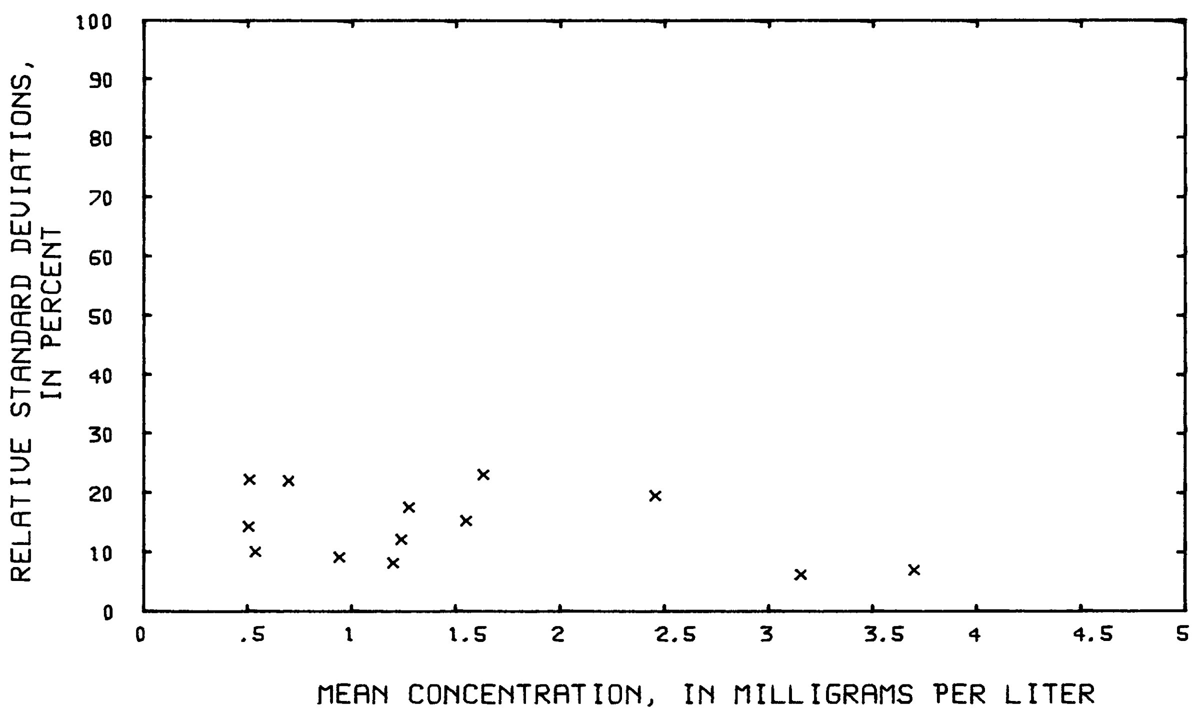


Figure 236.--Precision data for ammonia + organic nitrogen as N, dissolved, at the Denver laboratory.

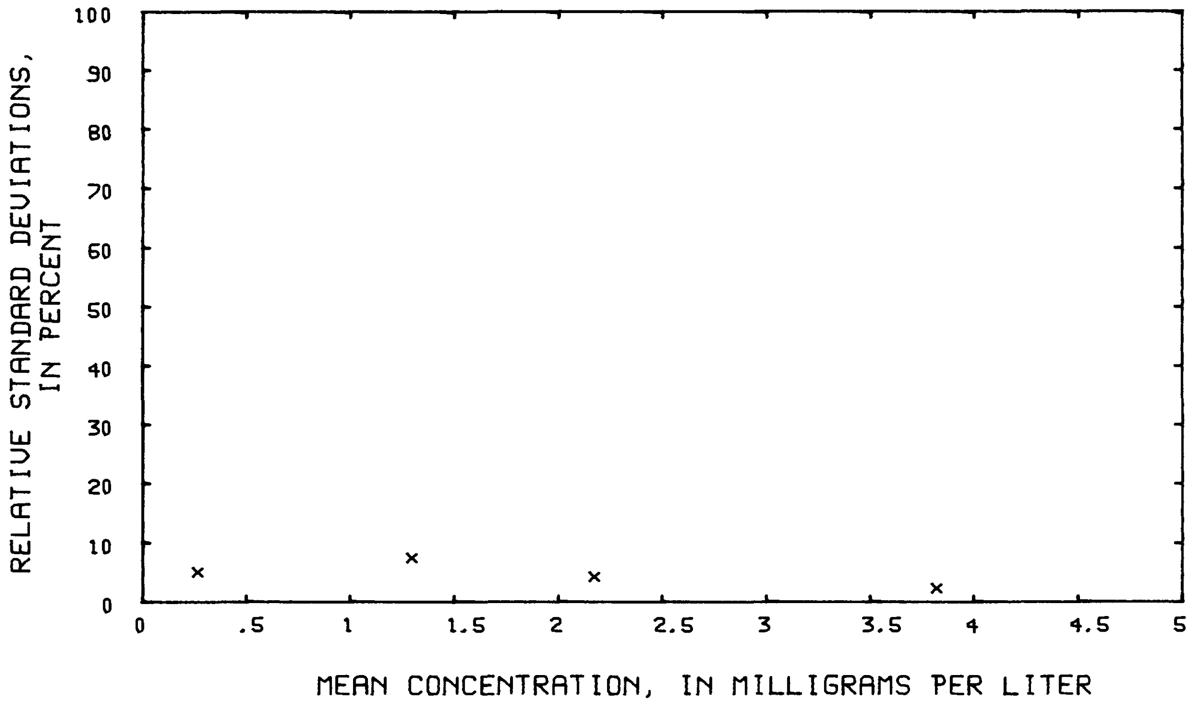


Figure 237.--Precision data for nitrite + nitrate nitrogen as N, dissolved, at the Atlanta laboratory.

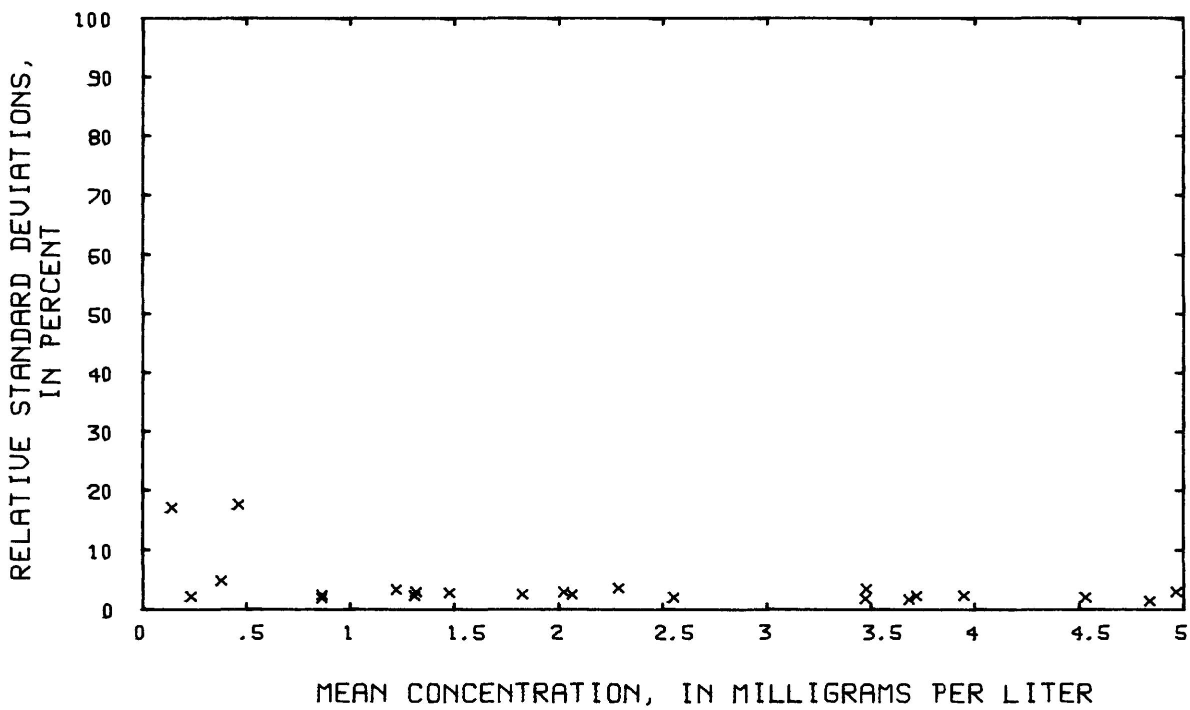


Figure 238.--Precision data for nitrite + nitrate nitrogen as N, dissolved, at the Denver laboratory.

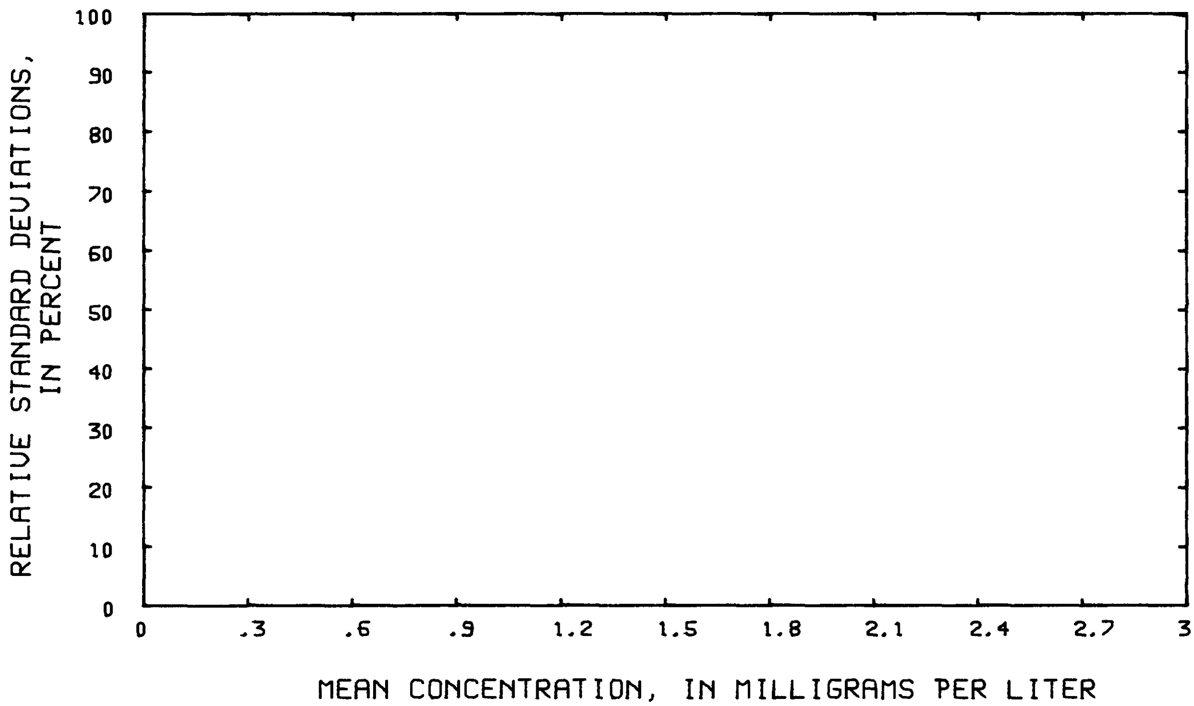


Figure 239.--Precision data for nitrite nitrogen as N, dissolved, at the Atlanta laboratory.

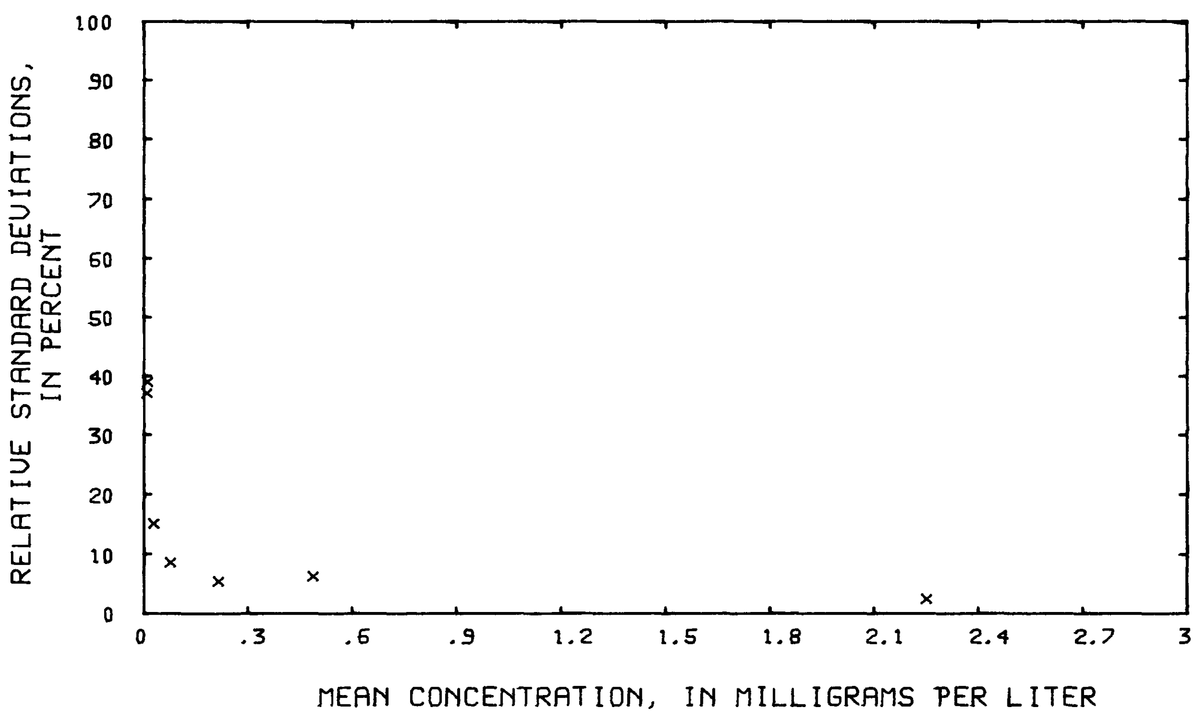


Figure 240.--Precision data for nitrite nitrogen as N, dissolved, at the Denver laboratory.

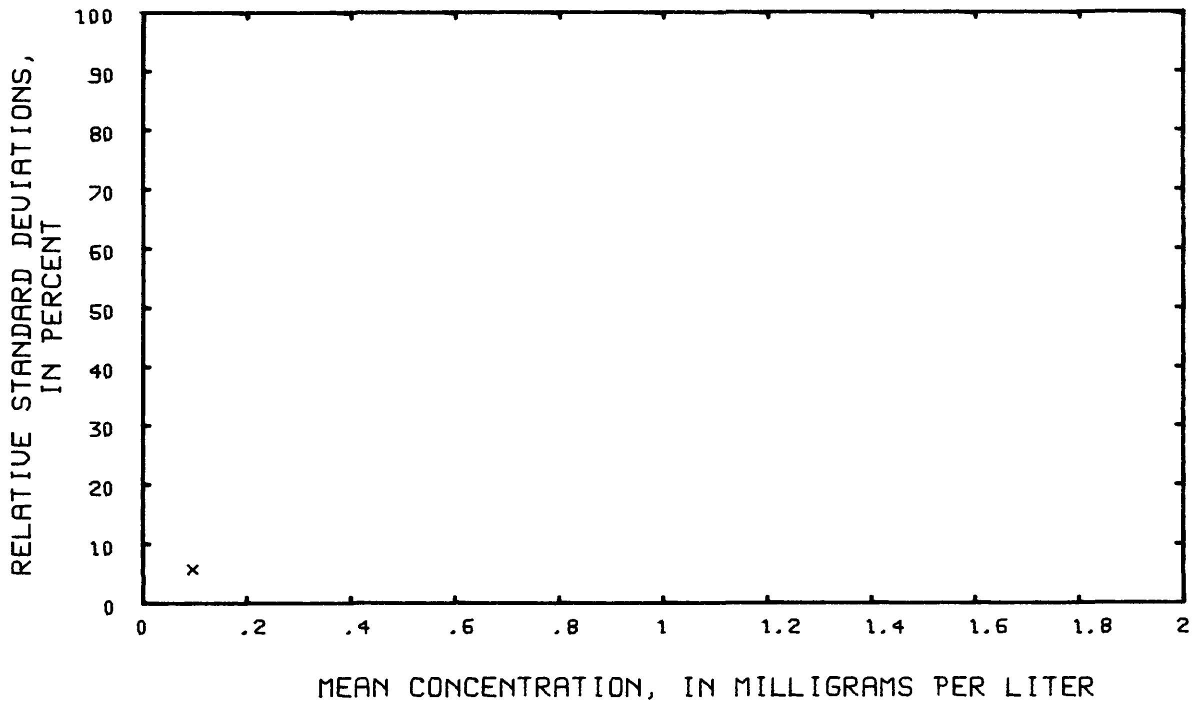


Figure 241.--Precision data for orthophosphate phosphorus as P, dissolved, at the Atlanta laboratory.

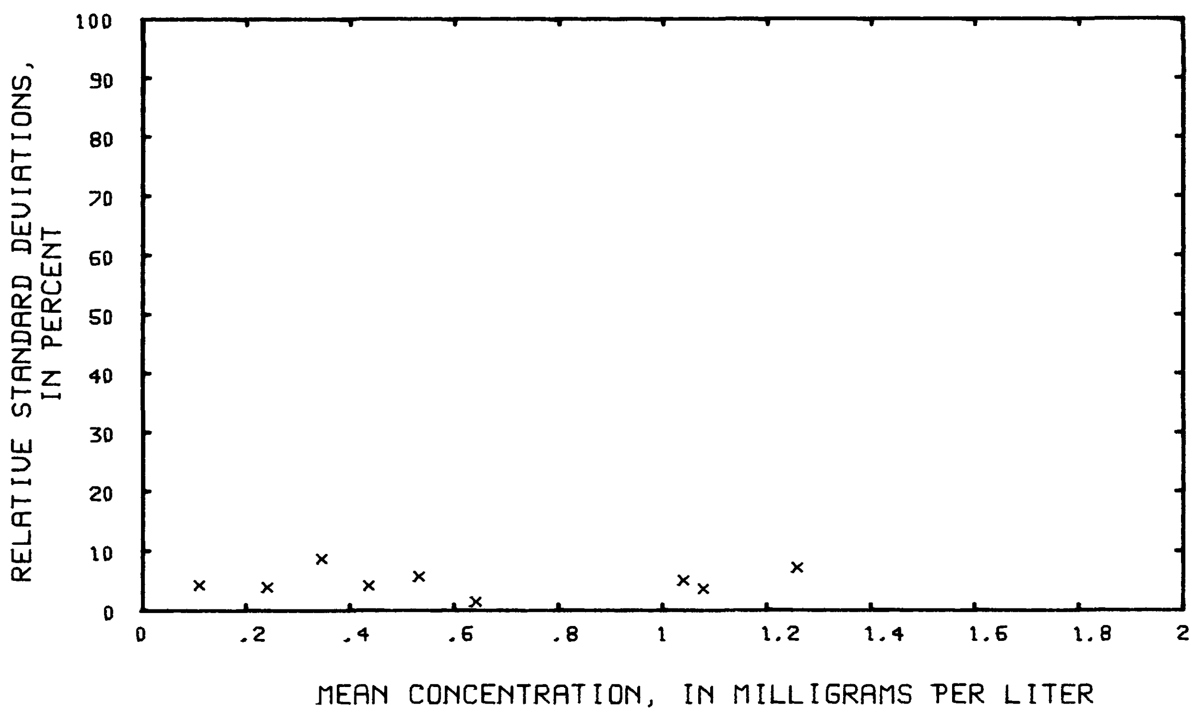


Figure 242.--Precision data for orthophosphate phosphorus as P, dissolved, at the Denver laboratory.

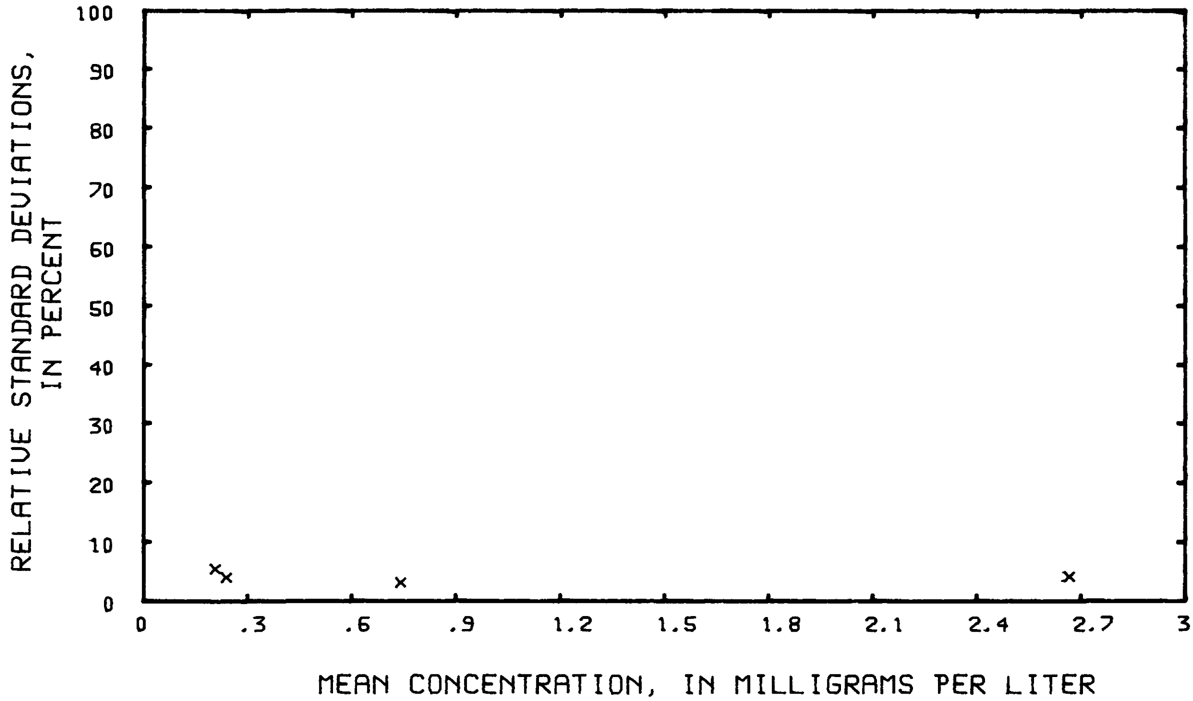


Figure 243.--Precision data for phosphorus as P, dissolved, at the Atlanta laboratory.

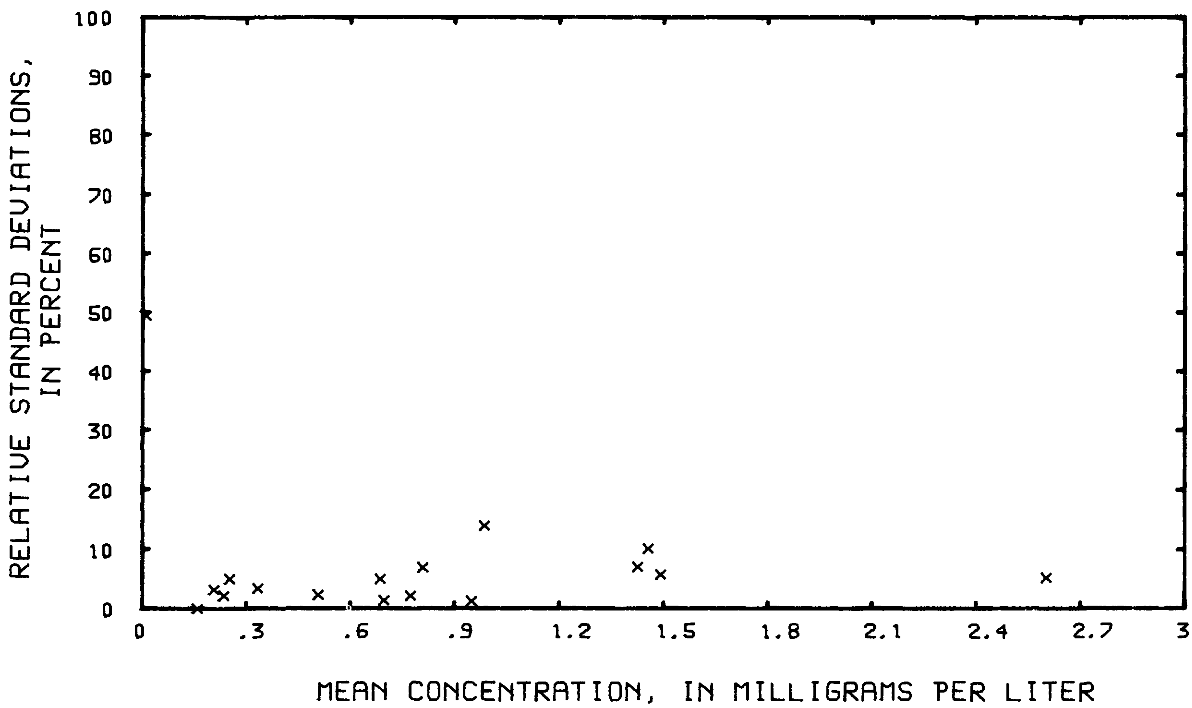


Figure 244.--Precision data for phosphorus as P, dissolved, at the Denver laboratory.

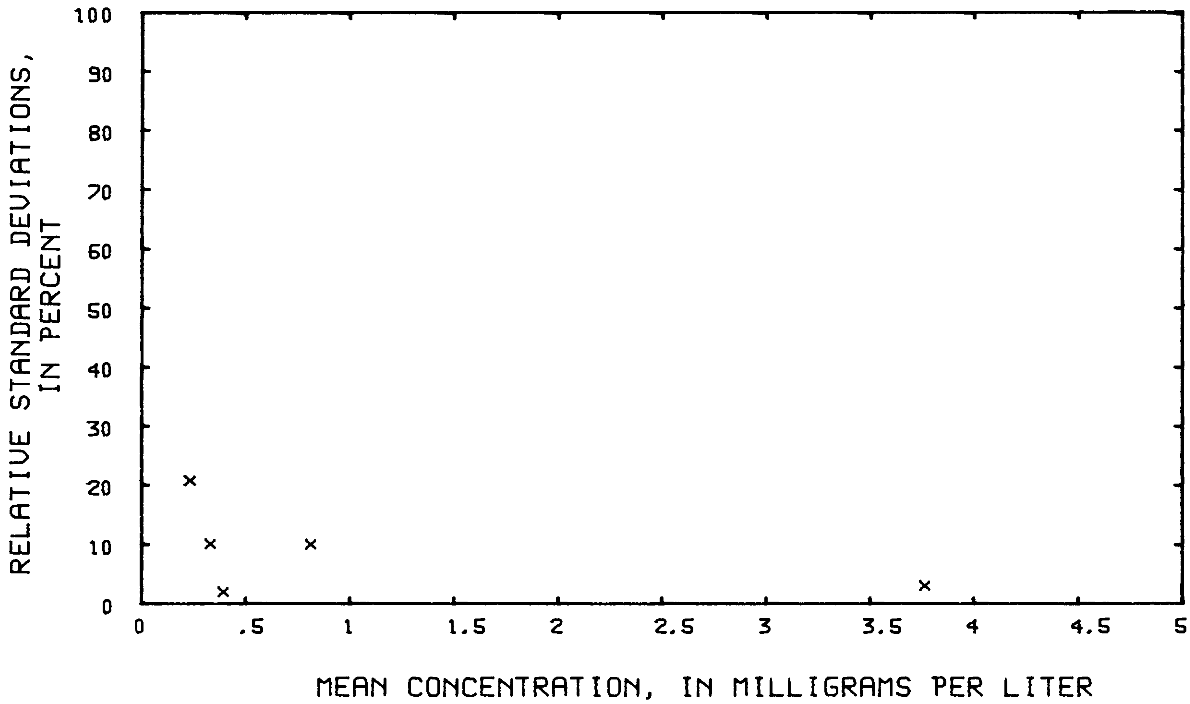


Figure 245.--Precision data for calcium, dissolved, (precipitation) at the Denver laboratory.

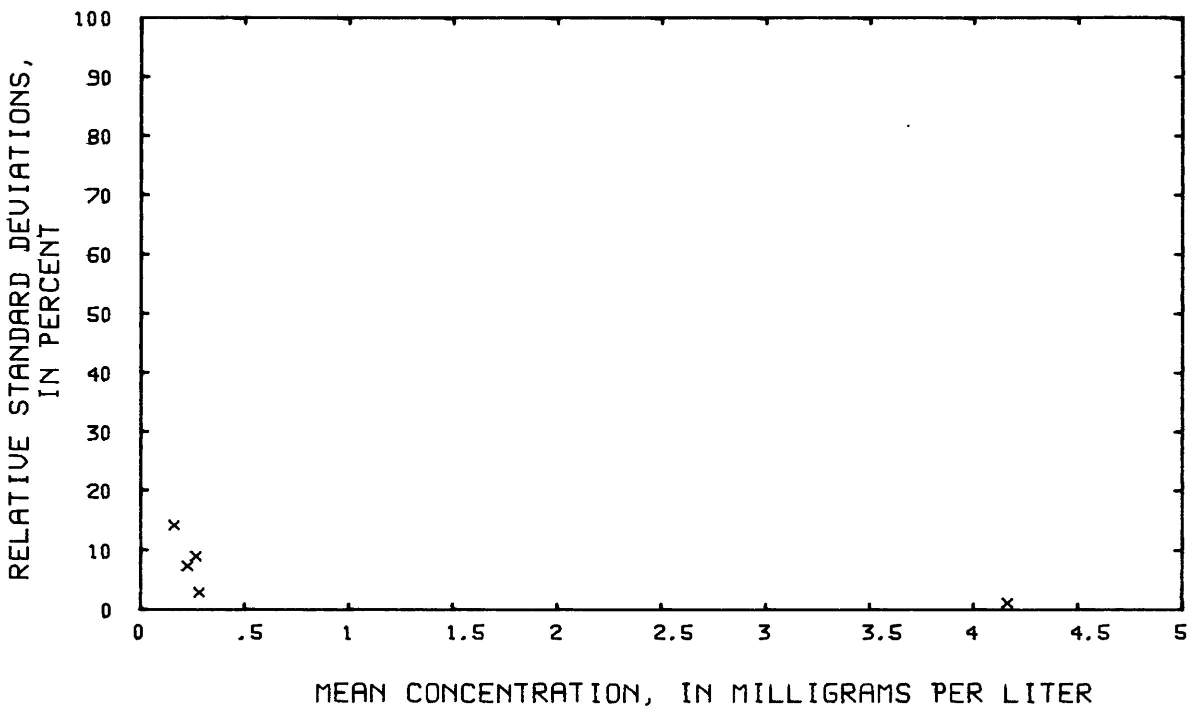
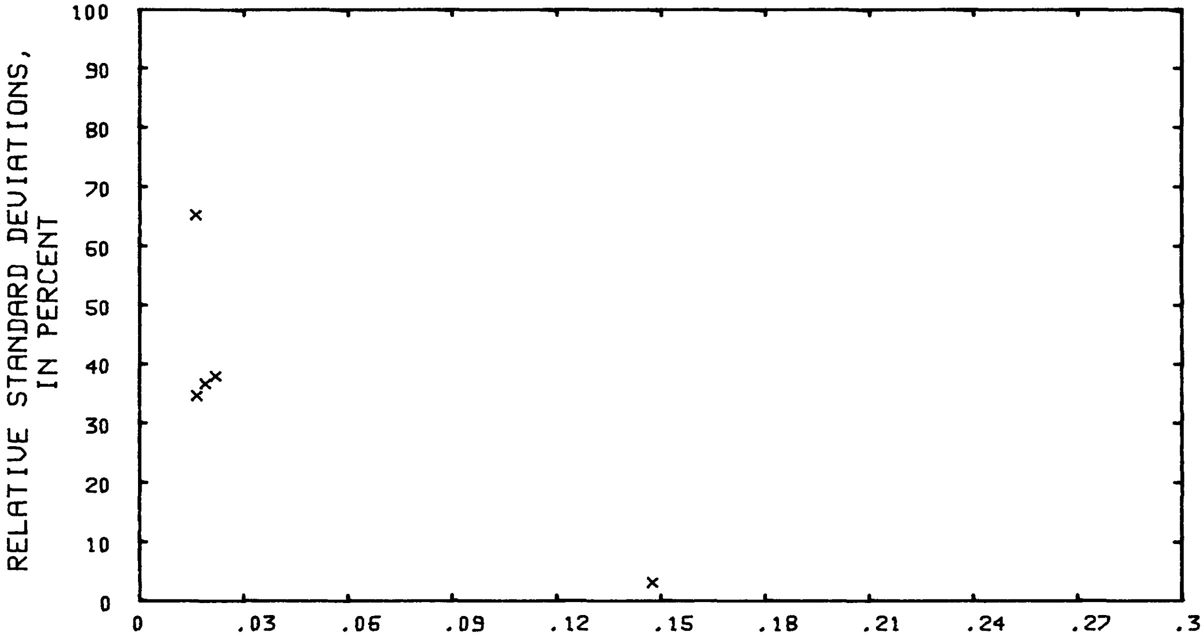
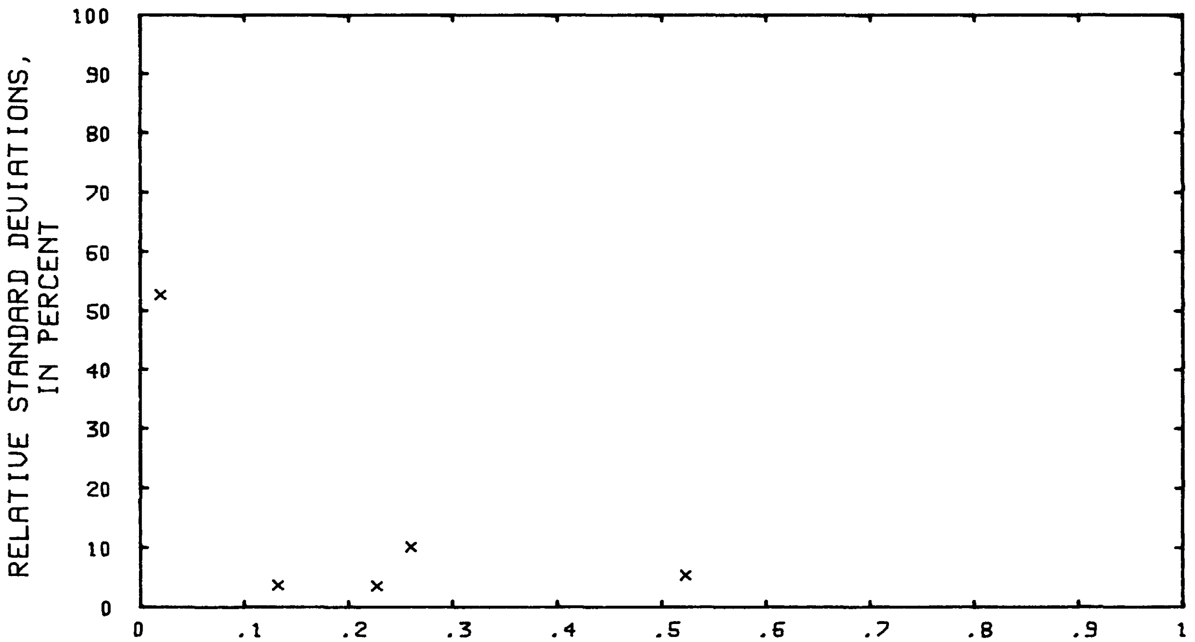


Figure 246.--Precision data for chloride, dissolved, (precipitation) at the Denver laboratory.



MEAN CONCENTRATION, IN MILLIGRAMS PER LITER

Figure 247.--Precision data for fluoride, dissolved, (precipitation) at the Denver laboratory.



MEAN CONCENTRATION, IN MILLIGRAMS PER LITER

Figure 248.--Precision data for magnesium, dissolved, (precipitation). at the Denver laboratory.

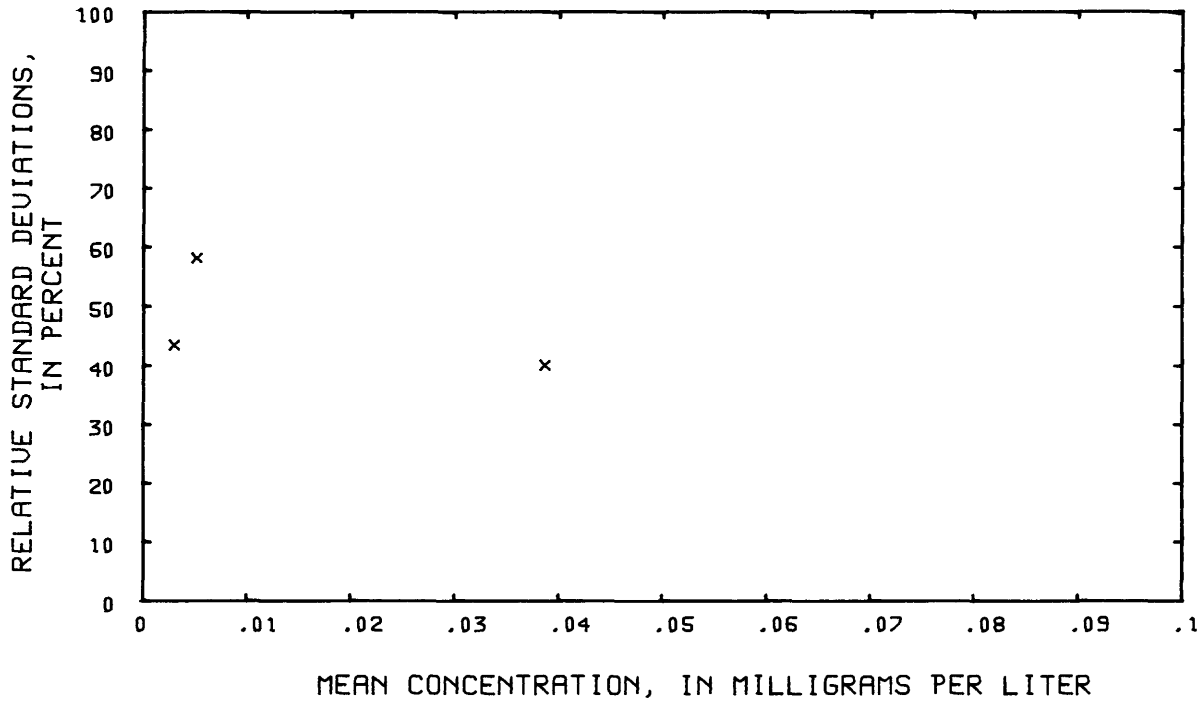


Figure 249.--Precision data for ammonia nitrogen as N, dissolved, (precipitation) at the Denver laboratory.

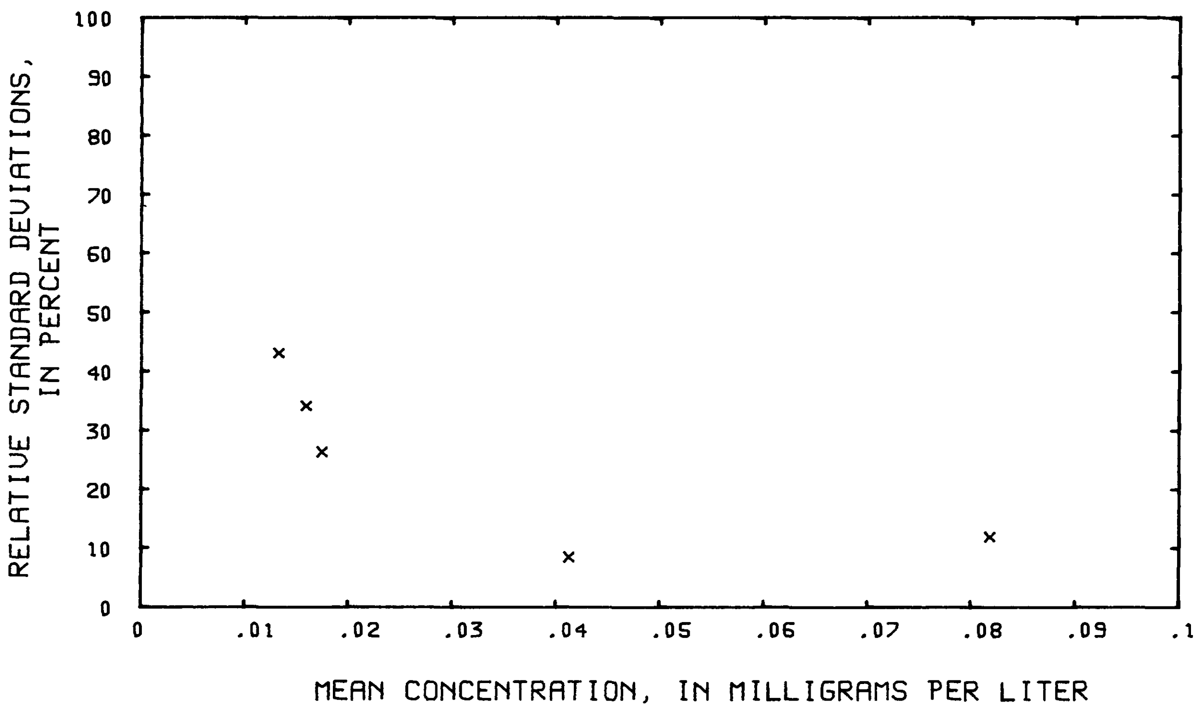


Figure 250.--Precision data for nitrate nitrogen as N, dissolved, (precipitation) at the Denver laboratory.

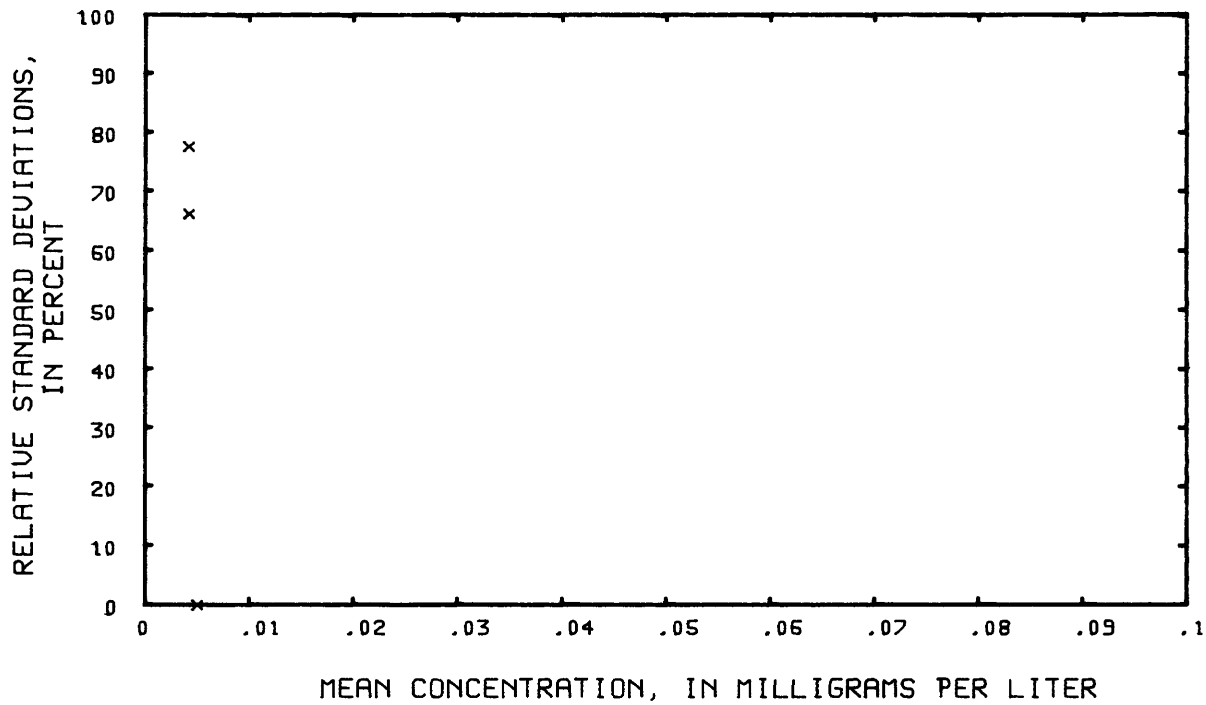


Figure 251.--Precision data for phosphorus as P, dissolved, (precipitation) at the Denver laboratory.

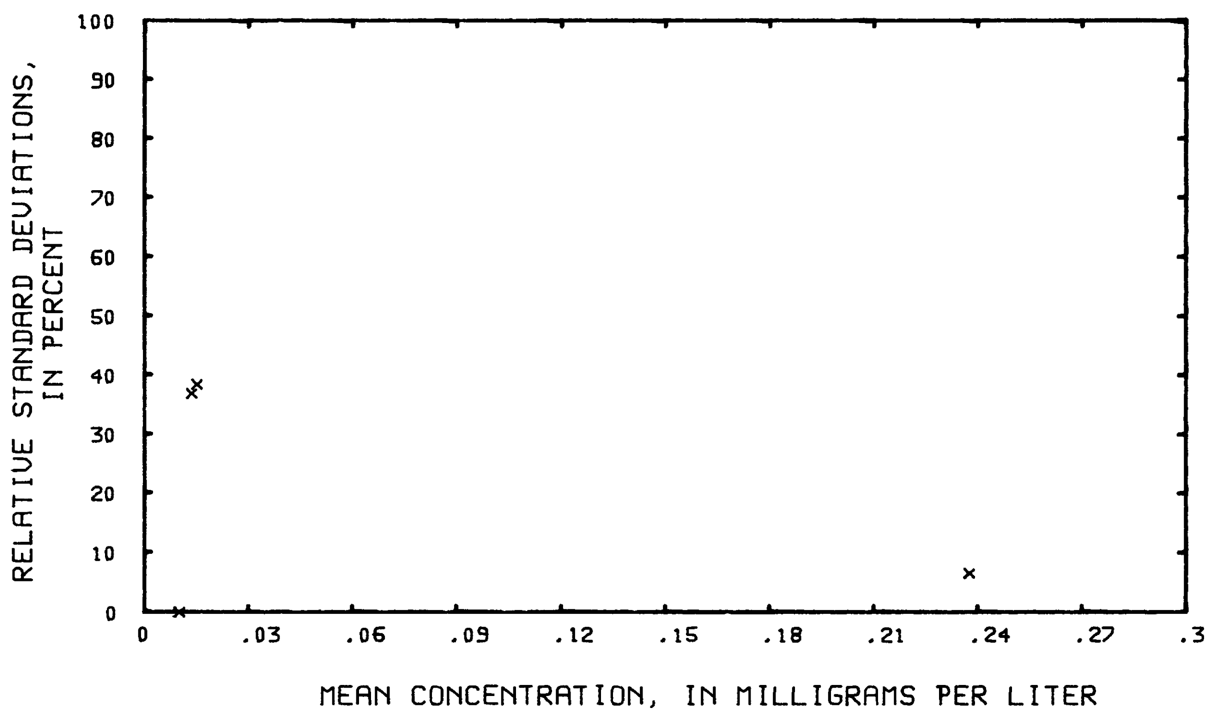


Figure 252.--Precision data for potassium, dissolved, (precipitation) at the Denver laboratory.

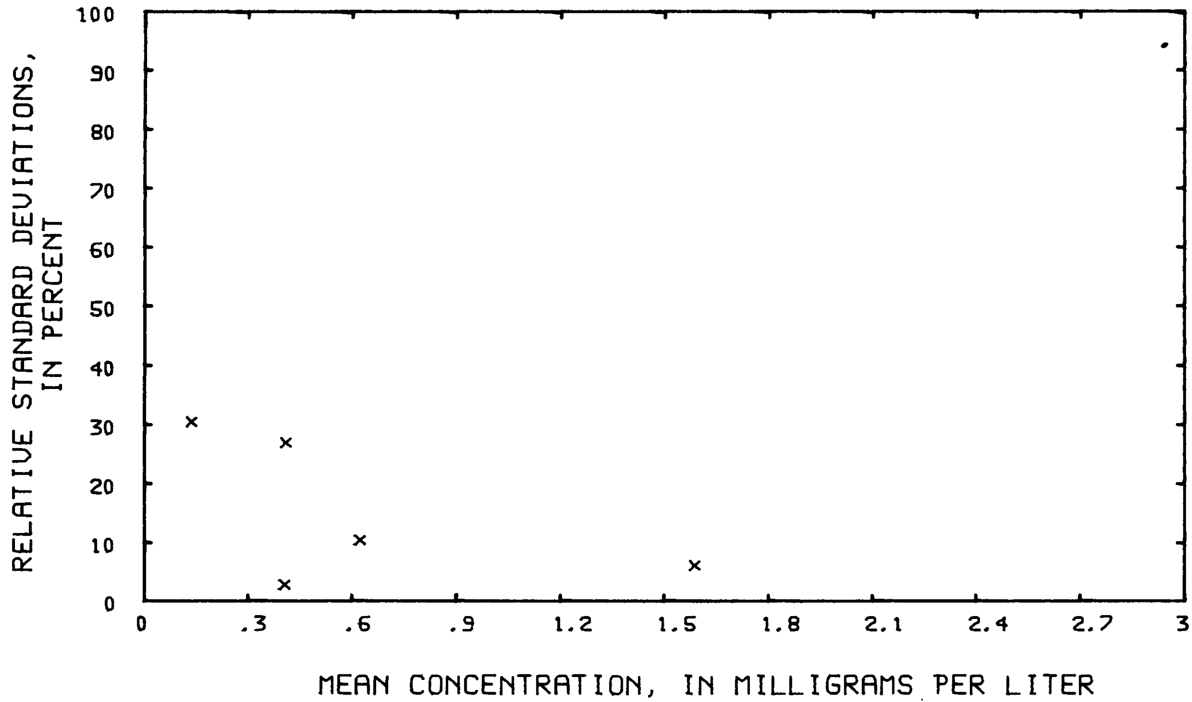


Figure 253.--Precision data for sodium, dissolved, (precipitation) at the Denver laboratory.

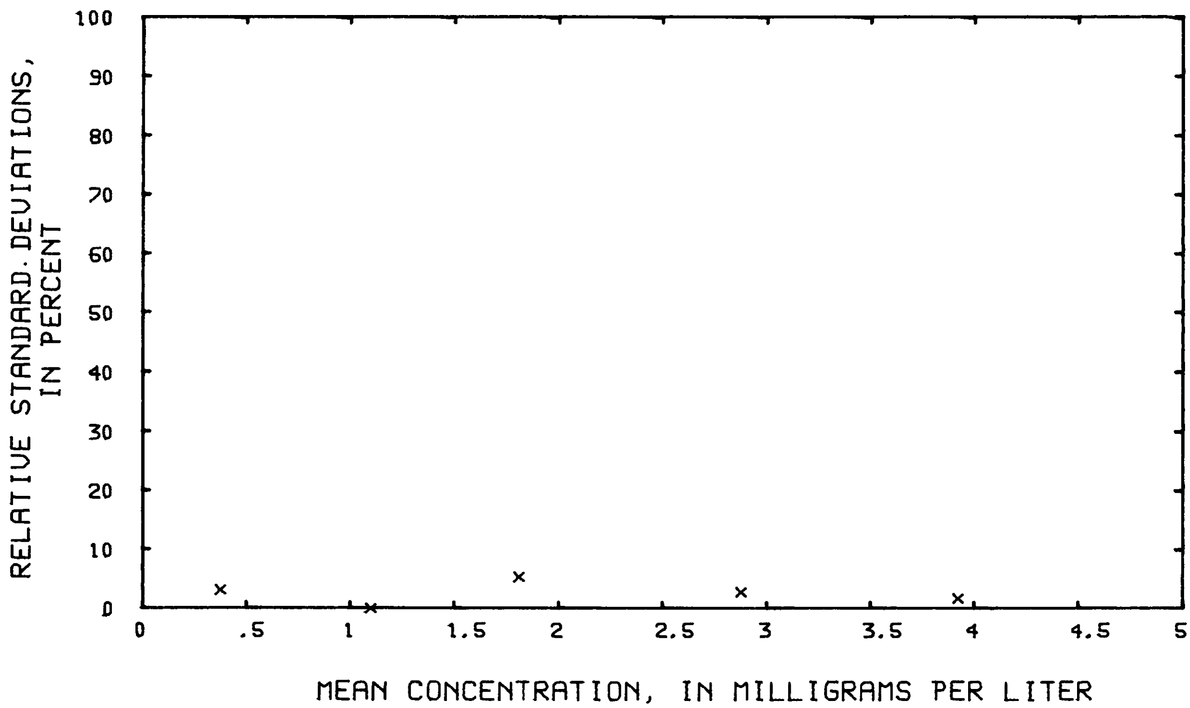


Figure 254.--Precision data for sulfate, dissolved, (precipitation) at the Denver laboratory.

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