STATISTICAL EVALUATION OF ADDITIONAL HYDROCHEMICAL DATA

FROM THE

SADDLE MOUNTAINS, WANAPUM AND GRANDE RONDE BASALTS

BASALT WASTE ISOLATION PROJECT

HANFORD SITE

DRAFT

April 4, 1985
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Williams and Associates, Inc.

Viola, Idaho

DRAFT

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1. INTRODUCTION

This report is the second of two reports in which the hydrochemical data from the Basalt Waste Isolation Project (BWIP) have been analyzed statistically. The first report (Williams and Associates, Inc., 1983) analyzed BWIP hydrochemical data obtained by the Nuclear Regulatory Commission from Rockwell Hanford Operations during the workshop held in Richland, Washington, in July 1982. These data comprise the results of chemical analyses of water samples obtained by Rockwell during their drilling and testing program at the BWIP site prior to that date. These data include analyses of samples from the Saddle Mountains, Wanapum and Grande Ronde Formations, mainly within the Hanford Site boundaries. The first data set includes few data, especially from the Grande Ronde Basalts in the vicinity of the Reference Repository Location (RRL). Isotopic data also were obtained at the July 1982 workshop but the isotopic data were not used in this study.

Additional data have been collected since the July 1982 workshop. It was deemed appropriate for the NRC to obtain these additional data for evaluation in mid 1984. The water quality sampling program was interrupted in March of 1984 in order to allow other programs to proceed without

interference.

A significant amount of data has been added to the pre-July 1982 data base. This contribution is important especially with respect to the samples collected in the vicinity of the RRL. Additional samples have been collected from the Grande Ronde Formation which increase the vertical distribution of data. The target repository horizon is the Cohassett Flow interior in the Grande Ronde Formation.

As noted in the first report (Williams and Associates, Inc., 1983), Rockwell asserted that waters in the major geologic units (Saddle Mountains, Wanapum and Grande Ronde Formations) are distinguishable on the basis of hydrochemistry (U. S. Dept. of Energy, 1982, p. 5.1-184 & 202). The purpose of the first study was to test this assertion using statistical procedures applied to Rockwell's data base. The purpose of the present study is to expand this effort using the new expanded data base.

The issue of hydrochemical distinguishability of basalt formations is important because of its implications to aquifer isolation. Rockwell states in the BWIP Site Characterization Report (U. S. Dept. of Energy, 1982, p. 5.1-139 & 5.1-184) that the differences in hydrochemical data among basalt formations constitute evidence that the basalt formations are isolated hydraulically. Specifically, Rockwell concludes in the SCR (U. S. Dept. of Energy, 1982, p. 5.1-139 & 5.1-184) that the hydrochemical data indicate that mixing of waters among basalt formations does not occur at the BWIP site. The NRC has concluded in the Draft Site Characterization Analysis (U. S. Nuclear Regulatory Commission, 1983) that many factors can influence whether or not mixing occurs among aquifers in a multilayer aquifer system.

Williams and Associates has concluded that the problem of determining whether or not mixing occurs on the basis of hydrochemical data is sufficiently complex that the problem must be broken into parts in order to understand whether or not mixing occurs.

We have concluded that the first necessary step is to determine with the maximum possible degree of confidence whether the existing hydrochemical data base is distinct by formation. The term "distinct" must not be confused with hydraulic isolation. If it is possible to demonstrate statistically that the ground waters in the Saddle Mountains Formation, the Wanapum Formation and the Grande Ronde Formation can be distinguished from one another then it is permissible to proceed to the second step of the problem. The second step of the problem requires evaluating other factors such as vertical saturated hydraulic conductivity data, vertical head distribution data, the natural evolution of the hydrochemistry in different units due to, e.g., the geothermal gradient, pH changes, Eh changes, and other chemical factors, and structural mapping data in order to determine whether these data are compatible with hydrochemical distinctness among basalt formations. It was specifically not the intent of the first report nor is it the intent of this second report to address the second step of the problem. We investigate only whether or not the hydrochemical data are distinct according to basalt formation. Without quantification of this information it is not reasonable to address step 2. This second report analyzes a larger and better distributed data base than the first report.

Univariate and multivariate analyses were performed on the data base described above in order to investigate hydrochemical distinctness among

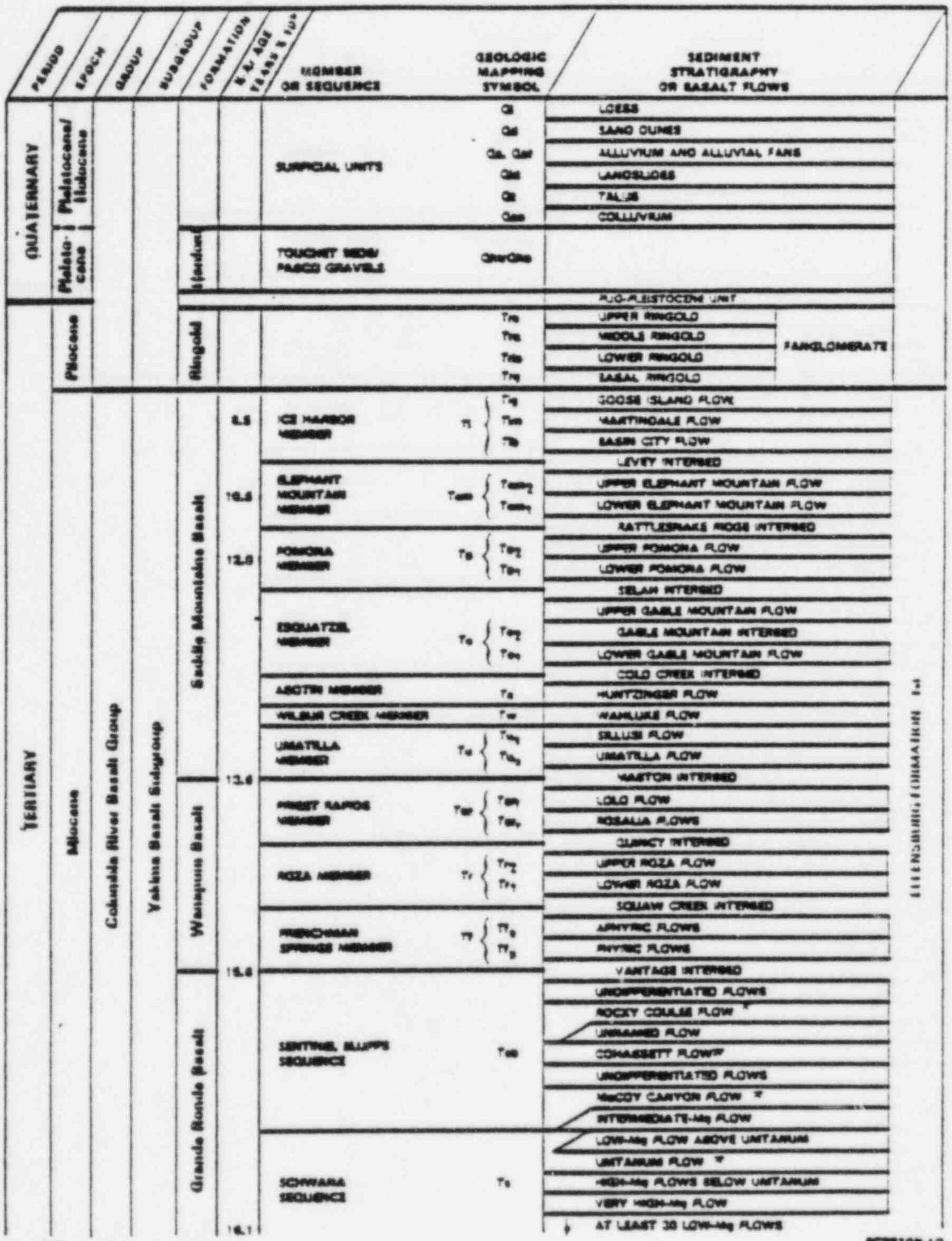
basalt formations at the BWIP site. Williams (1982) performed a similar evaluation in a different hydrogeologic environment. Williams showed that structural mapping and mineralogical mapping can be combined with statistical analysis of water quality data to interpret flow pathways and controls on the pathways within Mt. Emmons, Colorado.

2. GEOLOGY

The following geologic description is repeated in its entirety from the first report. This repetition minimizes the necessity for the reader to refer to the first report for background information.

The upper geologic units at the Hanford site consist of the suprabasalt sediments (Figure 2.1). These sedimentary deposits include the Hanford and Ringold Formations. The geologic units of primary interest in this report are the underlying basalts. Principal basalt units include the Saddle Mountains, Wanapum, and Grande Ronde. The sedimentary interbeds of the Ellensburg Formation are intercalated within these basalt units. The majority of the interbeds occur within the Saddle Mountains and Wanapum basalts. The distribution of the interbeds within the geologic section is shown on Figure 2.1. No attempt is made in this analysis to distinguish between the water quality of samples obtained from basalts and from sediments. Most of the samples obtained from the Saddle Mountains Formation are from the sediments. This may account for some of the distinctness of the samples from the Saddle Mountains Formation as discussed subsequently. We could not test the relationship between the sediments and the basalts because too few groundwater samples are available from basalt flows in the Saddle Mountains Formation.

The Umtanum flow within the Schwana sequence (Grande Ronde Formation), the McCoy Canyon flow (Grande Ronde Formation) and the Middle Sentinel Bluffs flow (Grande Ronde Formation) are the major geologic units of interest. The Umtanum flow and the Middle Sentinel Bluffs flow (recently named the Cohassett flow) constitute potential repository horizons for the



*Candidate Horizon

Figure 2.1. Pasco Basin stratigraphy (Jackson et al., 1984).

BWIP site. Those geologic units overlying the repository horizons also are of considerable interest because these units are the probable avenues of waste migration via groundwater movement.

Geochemistry of the basalt rocks is illustrated on Tables 2.1 and 2.2. These tables present the general chemical make-up of the Saddle Mountains, Wanapum, and Grande Ronde Formations. A geochemical evolution of the groundwater is not addressed. We consider this to be a separate issue that cannot be addressed adequately until the data are analyzed to show quantitatively that the formations are or are not hydrochemically distinct. It should be noted that the geothermal gradient at the Hanford site has been measured at 35 to 45 degrees Centigrade per 1,000 meters (U. S. Dept. of Energy, 1982, p. 3.6-20). The mean unconfined groundwater temperature at the site is about 19 degrees Centigrade which is higher than the mean annual air temperature of 11.7 degrees Centigrade (U. S. Dept. of Energy, 1982, p. 5.1-90). The high temperatures may be pertinent because most minerals other than calcite, dolomite and a few sulfates are more soluble at higher temperatures.

The frequency of interbeds decreases with depth. DOE's Site Characterization Report (U. S. Dept. of Energy, 1982) indicates that 24% of the thickness of the Saddle Mountains Formation is interbeds (U. S. Dept. of Energy, 1982, p. 5.1-28), whereas no percentage thickness of interbeds is shown for the Wanapum or Grande Ronde Formations (Figure 2.1). Interbeds consist of clastic and volcaniclastic sediments (U. S. Dept. of Energy, 1982, p. 3.5-4). The volcaniclastic sediments were deposited as ashfall and by rivers flowing on the plateau (Rockwell International, 1981, p. 3-30).

Table 2.1 Basalt geochemistry, Grande Ronde (wt%) (Rockwell International, 1981, Table 4-1)

	N	Mean	Standard deviation	Minimum** value	Maximum** value	Standard error of mean
High-Mg Flows						
SiO_2	50	53.61	0.43	52.61	54.45	0.06
Al_2O_3	50	14.88	0.27	14.26	15.51	0.04
FeO*	50	12.01	0.52	10.89	12.89	0.07
MgO	50	4.88	0.20	4.38	5.34	0.03
CaO	50	8.75	0.19	8.36	9.20	0.03
Na_2O	50	2.60	0.17	2.13	3.17	0.02
K_2O	50	0.97	0.15	0.51	1.31	0.02
TiO_2	50	1.81	0.10	1.62	1.96	0.01
P_2O_5	50	0.28	0.02	0.25	0.38	0.00
MnO	50	0.21	0.01	0.19	0.23	0.00
Low-Mg Flows						
SiO_2	13	55.45	0.63	53.82	56.01	0.18
Al_2O_3	13	14.88	0.19	14.44	15.19	0.05
FeO	13	11.95	0.30	11.25	12.40	0.08
MgO	13	3.55	0.12	3.41	3.84	0.03
CaO	13	7.35	0.13	7.11	7.55	0.04
Na_2O	13	2.82	0.18	2.45	3.11	0.05
K_2O	13	1.63	0.33	1.17	2.47	0.09
TiO_2	13	1.91	0.03	1.87	1.96	0.01
P_2O_5	13	0.30	0.01	0.28	0.32	0.00
MnO	13	0.20	0.01	0.19	0.21	0.00
Umtanum Flow						
SiO_2	13	54.90	0.25	54.45	55.45	0.07
Al_2O_3	13	14.34	0.15	14.08	14.59	0.04
FeO	13	13.10	0.21	12.70	13.39	0.06
MgO	13	3.48	0.09	3.38	3.71	0.03
CaO	13	7.30	0.14	7.14	7.64	0.04
Na_2O	13	2.66	0.26	1.86	2.95	0.07
K_2O	13	1.48	0.24	0.94	1.71	0.07
TiO_2	13	2.17	0.04	2.12	2.23	0.01
P_2O_5	13	0.35	0.01	0.33	0.36	0.00
MnO	13	0.22	0.00	0.21	0.23	0.00
Very-High-Mg Flow						
SiO_2	10	51.87	0.42	50.82	52.42	0.13
Al_2O_3	10	15.09	0.24	14.79	15.57	0.07
FeO	10	11.89	0.21	11.50	12.16	0.07
MgO	10	5.75	0.15	5.53	6.02	0.05
CaO	10	9.93	0.22	9.68	10.43	0.07
Na_2O	10	2.80	0.18	2.50	3.01	0.06
K_2O	10	0.53	0.17	0.29	0.76	0.05
TiO_2	10	1.64	0.07	1.57	1.79	0.02
P_2O_5	10	0.27	0.02	0.25	0.30	0.01
MnO	10	0.22	0.03	0.20	0.30	0.01

*Total Fe given as FeO.

**Maximum and minimum values are for individual oxides.

Table 2.2 **Basalt geochemistry, Wanapum & Saddle Mountains (wt%)** (Rockwell International, 1981, Table 4-1)

Flow	Esquatzel Member		Asotin Member Huntzinger flow		Pomona Member		Elephant Mountain Member Lower flow	
	N = 44		N = 45		N = 67		N = 23	
Mean, One Std. Dev.	$\bar{X}$	1σ	$\bar{X}$	1σ	$\bar{X}$	1σ	$\bar{X}$	1σ
SiO_2	52.78	0.47	51.43	0.82	51.81	0.38	50.76	0.33
AL_2O_3	14.24	0.27	16.06	0.56	15.41	0.28	13.76	0.30
TiO_2	3.02	0.10	1.58	0.12	1.63	0.06	3.49	0.06
FeO*	11.68	0.50	8.32	0.54	8.68	0.39	13.08	0.51
MnO	0.21	0.02	0.18	0.02	0.19	0.01	0.23	0.01
CaO	7.65	0.22	10.51	0.69	10.62	0.30	8.38	0.19
MgO	3.75	0.22	6.82	0.97	6.73	0.27	4.22	0.14
K_2O	1.78	0.13	0.67	0.42	0.53	0.10	1.30	0.10
NA_2O	2.50	0.14	2.16	0.20	2.16	0.12	2.29	0.21
P_2O_5	0.37	0.02	0.26	0.06	0.24	0.02	0.49	0.01
Flow	**Elephant Mountain Member upper flow (Ward Gap)**		**Ice Harbor Member Basin City flow**		**Ice Harbor Member Martindale flow**		**Ice Harbor Member Goose Island flow**	
	N = 10		N = 8		N = 14		N = 4	
Mean, One Std. Dev.	$\bar{X}$	1σ	$\bar{X}$	1σ	$\bar{X}$	1σ	$\bar{X}$	1σ
SiO_2	50.57	0.28	47.62	0.29	48.44	0.49	47.46	0.67
AL_2O_3	13.78	0.22	14.04	0.21	14.18	0.36	13.17	0.39
TiO_2	3.43	0.08	3.59	0.04	3.25	0.13	3.64	0.05
FeO*	13.26	0.39	13.54	0.28	12.38	0.87	15.32	0.44
MnO	0.22	0.01	0.23	0.01	0.23	0.01	0.28	0.01
CaO	8.54	0.13	9.71	0.28	10.20	0.59	8.85	0.11
MgO	4.26	0.24	5.57	0.20	5.65	0.36	4.31	0.15
K_2O	1.20	0.12	0.68	0.11	0.68	0.17	1.22	0.06
NA_2O	2.27	0.14	2.23	0.11	2.30	0.13	2.25	0.16
P_2O_5	0.47	0.02	0.78	0.04	0.68	0.04	1.49	0.04

NOTE: Analyses are in wt%. Samples are core that was collected from drill holes and specimens from type localities.

*Total Fe expressed as FeO.

Table 2.2 Cont'd

Flow	Frenchman Springs Member plagioclase phyric flows		Frenchman Springs Member aphyric flows		Roza Member		Priest Rapids Member Rosalia flow	
	N = 43		N = 28		N = 13		N = 15	
Mean, One Std. Dev.	$\bar{X}$	1σ	$\bar{X}$	1σ	$\bar{X}$	1σ	$\bar{X}$	1σ
SiO_2	51.24	0.37	51.27	0.39	50.60	0.35	49.85	0.35
AL_2O_3	13.93	0.29	14.04	0.32	14.35	0.37	13.70	0.21
TiO_2	2.98	0.08	2.92	0.08	3.01	0.11	3.48	0.05
FeO^*	12.83	0.44	12.69	0.37	12.44	0.54	13.47	0.31
MnO	0.24	0.01	0.23	0.01	0.23	0.01	0.24	0.01
CaO	8.34	0.17	8.34	0.15	8.65	0.20	8.55	0.19
MgO	4.22	0.25	4.21	0.23	4.59	0.31	4.49	0.22
K_2O	1.15	0.14	1.29	0.12	1.17	0.13	1.05	0.20
NA_2O	2.54	0.14	2.49	0.17	2.43	0.20	2.50	0.22
P_2O_5	0.53	0.05	0.52	0.04	0.54	0.03	0.66	0.02

Flow	Priest Rapids Member Lolo flow		Umatilla Member Sillusi flow		Umatilla Member Umatilla flow		Wilbur Creek Member Wahluke flow	
	N = 19		N = 26		N = 24		N = 4	
Mean, One Std. Dev.	$\bar{X}$	1σ	$\bar{X}$	1σ	$\bar{X}$	1σ	$\bar{X}$	1σ
SiO_2	49.87	0.53	54.31	0.73	53.65	0.59	53.43	0.35
AL_2O_3	14.28	0.30	14.70	0.60	14.51	0.27	15.01	0.28
TiO_2	3.15	0.09	2.83	0.30	2.99	0.11	1.87	0.02
FeO^*	12.20	0.45	10.48	0.92	10.87	0.72	9.66	0.21
MnO	0.24	0.01	0.22	0.02	0.22	0.05	0.19	0.01
CaO	9.00	0.63	6.60	0.64	6.68	0.37	8.50	0.19
MgO	5.18	0.31	2.61	0.26	3.00	0.31	4.61	0.25
K_2O	0.98	0.11	2.62	0.36	2.52	0.14	1.90	0.16
NA_2O	2.45	0.17	2.82	0.25	2.84	0.24	2.37	0.15
P_2O_5	0.66	0.02	0.81	0.05	0.72	0.02	0.45	0.01

Clastic sediments derived from the plutonic and metamorphic rocks of the Rocky Mountain terrain also are present (Rockwell International, 1981, p. 3-30).

Several known and some potential geologic structures exist at the Hanford site. Several hydrogeochemical implications are possible in view of the potential effect these structures might have on groundwater flow. These structures might have no discernable effect on groundwater quality; but it is aguable also that these structures might retard lateral groundwater flow or provide preferential hydraulic conductivity pathways for groundwater flow in the vertical direction. The major hydrogeochemical issue addressed is whether the major basalt formations (Saddle Mountains, Wanapum, and Grande Ronde) are isolated hydraulically from each other by flow interiors with low vertical saturated hydraulic conductivity or whether there is a significant vertical exchange of groundwater among these formations. This issue cannot be addressed until the hydrochemical distinctness of the waters in the basalt formations is resolved in a defensible quantitative manner.

3. DATA

The boreholes used for the collection of data for this evaluation are widely scattered on and around the Hanford site (Figure 3.1). Numerous geologic units are represented by water chemistry analyses from different boreholes but few boreholes offer a comprehensive representation of water chemistry analyses for the entire geologic section. The distribution of boreholes is not random which presents some difficulty in testing hypotheses as noted later in this report. The distribution of boreholes for the current data base is better than the distribution that was available for the study presented in Williams and Assoc., Inc. (1983). The geologic units that constitute sample sources range from the Saddle Mountains Formation through the Grande Ronde Formation. The computer code used to designate the stratigraphic units is presented in Appendix A. Interbeds dominate the sample sources in the Saddle Mountains Formation. Flow tops dominate the sample sources in the Wanapum and Grande Ronde Formations. This observation may be important to the interpretation of water chemistry data as noted subsequently herein.

The chemical data in the appendix contain concentrations of some constituents that were reported as being less than some detection limit. For purposes of a consistent data base these values are shown in the appendices as being equal to the detection limit. Detection limits are indicated by a minus sign preceding the concentration value in Appendix B. In addition the detection limits are not always constant for the same variable; this inconsistency is a consequence of the fact that multiple samples were sent to different laboratories with different analytical

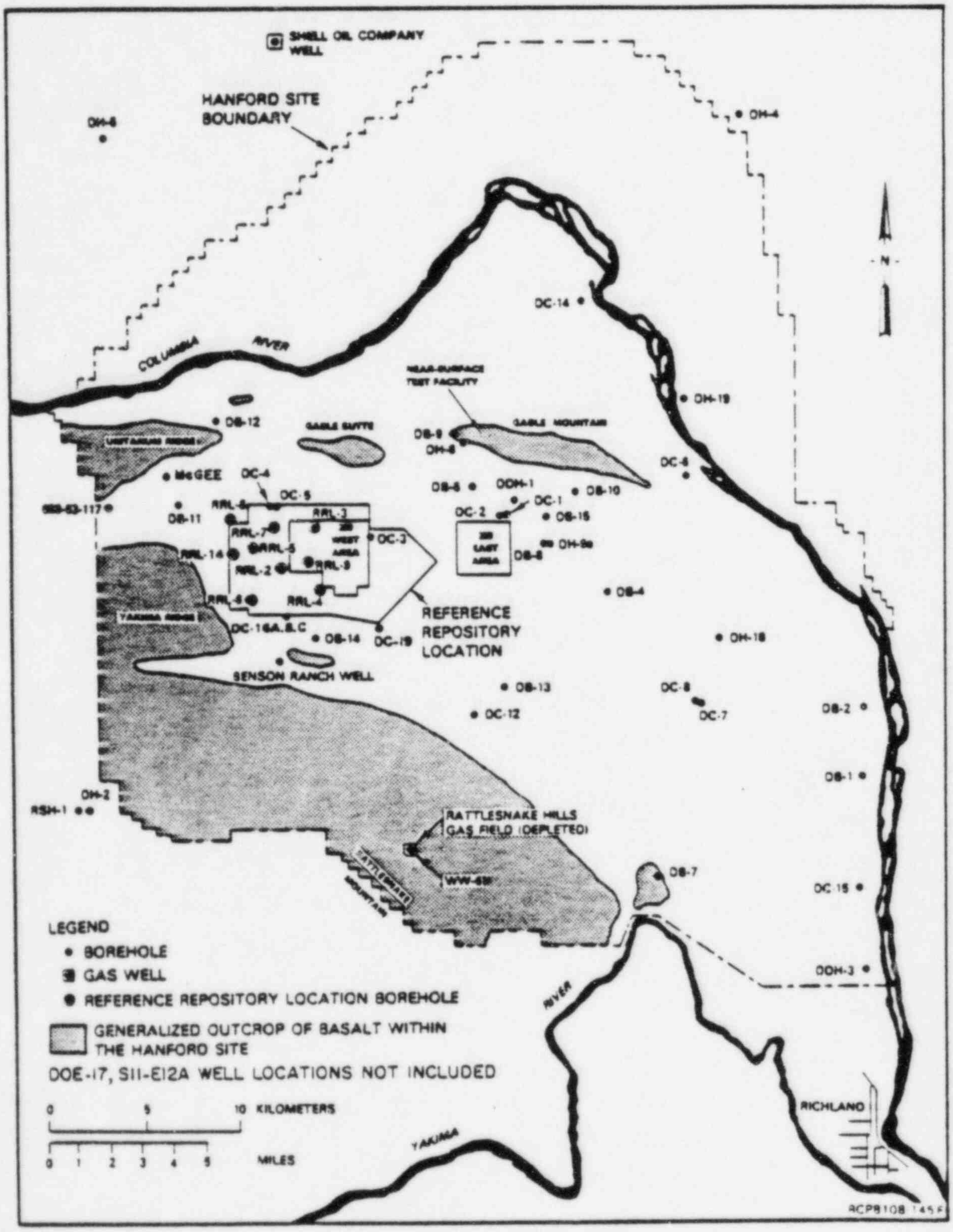


Figure 3.1. Selected borehole and well locations (modified after BWIP handout).

capabilities. From a statistical analysis viewpoint these procedures should not be deleterious.

The hydrochemical data list received by the NRC contains many instances in which the same interval and basalt flow were sampled on several occasions in the same borehole. Multiple sampling is particularly prevalent with respect to borehole DC-14. A continuous flowing discharge test resulted in approximately 35 samples and analyses appearing in the data listing in addition to the multiple samples and analyses that occurred during normal drilling and testing. The multiple analysis presented in the data from borehole DB-1 is a more common type of occurrence. The Mabton interbed was sampled and analyzed 4 times between July 1978 and May 1981. In cases such as these the samples selected for statistical evaluation in this report were selected based on several judgemental factors with a single primary objective. This objective is to represent each sampled basalt flow from each borehole with one sample and corresponding valid analysis. Each sample is identified by a record number. Borehole DC-14 is an exception to this criteria. Two samples from the end points of the testing period were selected to evaluate the possible effects of contamination by drilling fluid on groundwater quality. These two samples were selected in addition to samples obtained during the normal drill and test sequence. The multiple samples from each basalt flow-borehole were culled based on the time interval between drilling and sampling. The most recent sample was selected except where the sampling method shed doubt on the validity of the sample. Multiple methods of sampling have been employed at the BWIP site. These methods include swabbing, air lift pumping, pumping with a submersible pump,

and free flowing discharge from artesian wells with a hydraulic head above ground surface. Samples were selected based on the most desirable method of sampling; the methods are listed in order from the least desirable to the most desirable.

A cation-anion balance could not be performed on the data presented in Appendix B because two major anions are missing from the chemical analysis listing. These major anions are bicarbonate (HCO_3) and carbonate (CO_3). All data in Appendix B are considered in the evaluation; the sequence of data evaluation procedures is described in Section 4.2 Statistical Procedures. An ion balance was performed on the data used in the first report (Williams and Associates, Inc., 1983). Only 5 samples did not meet the 10% balance criteria used in the first report.

The hydrochemical data are influenced by many factors such as temperature. The geothermal gradient at the BWIP site appears to be uniform and fairly consistent. This gradient results in groundwater temperatures of approximately 15^{o}C in the shallowest basalt units to 60^{o}C in the deeper Grande Ronde flows. This temperature variation, which appears to increase linearly with depth, may have a significant impact on various ion concentrations in the water samples. The interrelationships of physical variables, geochemical variables, and hydrochemical variables is extremely complex.

Several hydrochemical variables were selected based on subsequent statistical analyses of the data. The selected hydrochemical variables are plotted as ion concentrations versus depth below land surface (Appendix C). The variables selected for this qualitative examination of the

interrelationship of physical, geochemical, and hydrochemical variables are pH, insitu temperature, magnesium (Mg), potassium (K), and fluoride (F). Four borehole locations were selected for this qualitative examination. These borehole locations are DC-16a and c and RRL-2 which are within or near the RRL and DC-14 and DC-15 which are adjacent to the Columbia River. Boreholes DC-16a and DC-16c are considered as one borehole due to their close areal proximity. Their combined data bases result in an extensive depth and stratigraphic representation of hydrochemical and temperature data. These four borehole locations are the only boreholes that have a reasonably comprehensive representation of data over the greatest depth of interest.

These plots of ion concentrations, pH, and temperature versus depth do not illustrate a clear cut relationship between any of the variables. The specific relationship of interest is the ion concentrations to temperature. There is no apparent relationship of ion concentrations or pH to temperature.

3.1 Hydrochemical Data

The data used in this study consist of 253 water sample analyses reported in the BWIP Hydrochemistry Data Base as chemical data printouts dated February 22, 1984. Record number, sample number, formation identity, pH, specific conductivity, field alkalinity, chloride, fluoride, sulfate, sodium, potassium, calcium, magnesium, silicon, total carbon, aluminum, barium, boron, cobalt, chromium, copper, iron, lithium, manganese, molybdenum, nickel, lead, strontium, and zinc were converted to machine

readable form (Appendix B) for use in the study.

3.2 Isotopic Data

The isotopic data collected at the BWIP site were not evaluated statistically. Primary emphasis was placed on the chemical data. Conceivably the separate analysis of the isotopic data could be informative; this analysis should be considered for future research. Emphasis is placed on the chemical data because the data base is larger and fewer questions exist concerning the validity of sampling procedures and subsequent analyses.

4. DATA ANALYSIS

4.1 Working Hypotheses

The following hypotheses are the same as those stated in our first report (Williams and Assoc., Inc., 1983). The primary issue is whether the hydrochemistry data can be distinguished according to basalt formations; but the statistical method used can segregate data areally as well as vertically. Consequently two sets of working hypotheses are of interest. These hypotheses are:

A1. Fracturing or vertical mixing caused by other factors preclude quantitatively distinguishing groundwaters among basalt formations (or flows) under the Hanford Reservation using concentrations of dissolved constituents in water samples obtained from each formation (or flow).

A2. Groundwaters as represented by water samples from different basalt formations (or flows) under the Hanford Reservation are largely distinct and can be distinguished by the concentrations of their dissolved chemical constituents.

If hypothesis A2 is valid, then one is justified in pursuing further the implication that the samples were derived from different flow paths that are isolated or semi-isolated vertically. However even under this condition some vertical mixing among nearly horizontal flow pathways could occur across confining layers even though the upper and lower hydrostratigraphic units have statistically significantly different concentrations of dissolved constituents. In a mathematical sense this condition can be viewed as necessary but not completely sufficient for hydraulic isolation. For this

reason we have used the words hydrostratigraphic unit distinctness as opposed to hydrostratigraphic unit isolation to deal with working hypothesis A2 throughout this report.

B1. Water samples from wells on the Hanford Reservation statistically <u>cannot</u> be grouped spatially (areally) and

B2. Water samples from wells on the Hanford Reservation statistically <u>can</u> be grouped spatially (areally).

We reemphasize the fact that samples from the Saddle Mountains Formation are derived primarily from interbeds; consequently for the Saddle Mountains Formation working hypotheses A1 and A2 may simply reflect the effect of nonbasalt rock types on hydrochemistry. The possible implications of this observation should be researched further when more data become available.

4.2 Statistical Procedures

The analysis is divided into two parts: exploratory and confirmatory. In the exploratory analysis we calculate descriptive statistics in order to detect any coding errors or outliers in the data base and to determine if the data should be transformed. After transformation the data are standardized following which cluster analysis is performed to segregate the samples into relatively homogeneous groups or clusters of samples. Since hypotheses A1, A2 and B1, B2 concern the similarity or dissimilarity of chemical characteristics of <u>samples</u>, we are interested in clustering samples, not variables. Cluster analysis is useful for this purpose. Multivariate principal component analysis and factor analysis examine

relationships among <u>variables</u> and, hence, are not directly applicable. We perform two cluster analyses in this study. A preliminary cluster analysis is conducted on a subset of the data having complete information on most of the hydrochemical constituents. Only 85% of the data are used in this analysis. We performed a second cluster analysis on 94% of the data after deleting hydrochemical constituents that do not help to explain the preliminary clusters. Using a preliminary and final cluster analysis allows us to use as much of the data base as possible.

The result of the cluster analysis is a set of clusters or groups of samples which, if they survive additional scrutinous analysis, may support or deny the hypotheses discussed above. The confirmatory part of the analysis tests the statistical significance of differences among the clusters. Confirmatory analysis has two other purposes as well. We can determine which hydrochemical constituents or combination of constituents are important in differentiating among the clusters by using stepwise MANOVA and canonical analysis (Johnson and Wichern, 1982, ch. 10). The canonical analysis defines canonical variables much like principal components or factors. The new composite variables differ because the canonical variables define the dimensions along which the clusters can be segregated. Principal components or factors define the dimensions associated with the <u>overall</u> variability in the data. Secondly, we use discriminant analysis to clarify "gray" areas of the cluster analysis. Inevitably, some samples fall between clusters or fall into clusters that are made up of samples of an apparently different type. The discriminant analysis either substantiates or corrects the original placement of these statistically "anomalous" samples.

4.3 Exploratory Analysis

Summary statistics, stem and leaf plots (histograms), and box plots were calculated on each numerical response variable (SAS Institute Inc., 1982). Total carbon, cobalt, chromium, copper, lithium, nickel, and lead were deleted from the analysis because of large numbers of missing values and/or because many values are at or below detection limits. All the other variables except pH and field alkalinity have a skewed distribution; these variables were transformed logarithmically ($Y = \ln(X + 1)$). The variables pH and field alkalinity do not require transformation. The 253 data vectors were derived from 146 distinct water samples represented by one, two, and occasionally three laboratory analyses. The 253 data points were averaged to yield 146 observations -- one corresponding to each water sample. Not all 146 observations have values for each of the variables. However, 124 observations have complete data for pH, logarithm of specific conductance, field alkalinity, and logarithm of ion concentrations for chloride, fluoride, sodium, potassium, calcium, magnesium, aluminum, boron, and iron. Except for silicon and titanium, these ions constitute the major geochemical constituents of the basalt flows under the RRL. Silicon dioxide comprises about half of the basalts by weight but it does not provide a great deal of information about differences between basalt layers. Titanium was not assayed.

This study was initiated by conducting a preliminary cluster analysis using these 124 observations on 12 variables. The variables were standardized by converting raw data to Z scores according to:

$$Z = \frac{X - \overline{X}}{S},$$

where X is the observation on a variable and $\overline{X}$ and S are the mean and standard deviation, respectively. This procedure gives each variable equal weight in the analysis. We calculated distances between observations as Euclidean distances and used a hierarchical complete linkage clustering algorithm (Dixon, 1981, BMDP1M). Four preliminary clusters were identified.

Stepwise MANOVA (SPSS Inc., 1983, Discriminant Procedure) identified seven variables (Cl, Mg, K, pH, F, Na, and alkalinity) as discriminators among the four groups. In fact, 96.1% of the observations were classified into their correct clusters using only chloride, magnesium, potassium, pH, and fluoride. The four clusters identified generally represent two Saddle Mountain-Wanapum Formation groupings and two Wanapum-Grande Ronde Formation clusters. The fact that five variables are sufficient to identify the four clusters is not surprising if one examines the 12 x 12 correlation matrix in Table 4.3.1. The pattern of correlations suggest an association 1) among specific conductance, alkalinity, chloride, fluoride, sodium, and boron; 2) between calcium and magnesium; and 3) between aluminum and iron. Chloride and fluoride represent the information in variable association 1) and magnesium represents association 2). Aluminum and iron do not help differentiate these clusters. Most of the information content is captured if potassium and pH are evaluated in conjunction with chloride, fluoride, and magnesium. That is not to say that specific conductance, alkalinity, sodium, boron, and calcium are unimportant; but the information content of these five variables is represented adequately by the other five variables.

Table 4.3.1. Pooled within-groups correlation matrix.

	PH	SC	ALK	CL	F	NA	K	CA	MG	AL	B	FE
PH	1.000											
SC	-0.144	1.000										
ALK	0.083	-0.460	1.000									
CL	-0.342	0.653	-0.282	1.000								
F	0.209	0.493	-0.123	0.468	1.000							
NA	-0.201	0.687	-0.179	0.659	0.594	1.000						
K	-0.199	0.098	-0.155	0.317	0.015	0.103	1.000					
CA	-0.211	0.378	-0.316	0.115	-0.184	0.076	0.046	1.000				
MG	-0.142	0.036	0.146	-0.143	-0.371	-0.354	-0.198	0.602	1.000			
AL	-0.301	-0.177	0.258	-0.143	-0.105	-0.167	-0.099	-0.026	0.208	1.000		
B	-0.038	0.316	-0.128	0.316	0.447	0.402	0.011	0.008	-0.079	-0.125	1.000	
FE	-0.151	0.163	0.088	0.174	0.035	0.145	0.083	0.046	0.112	0.470	0.016	1.000

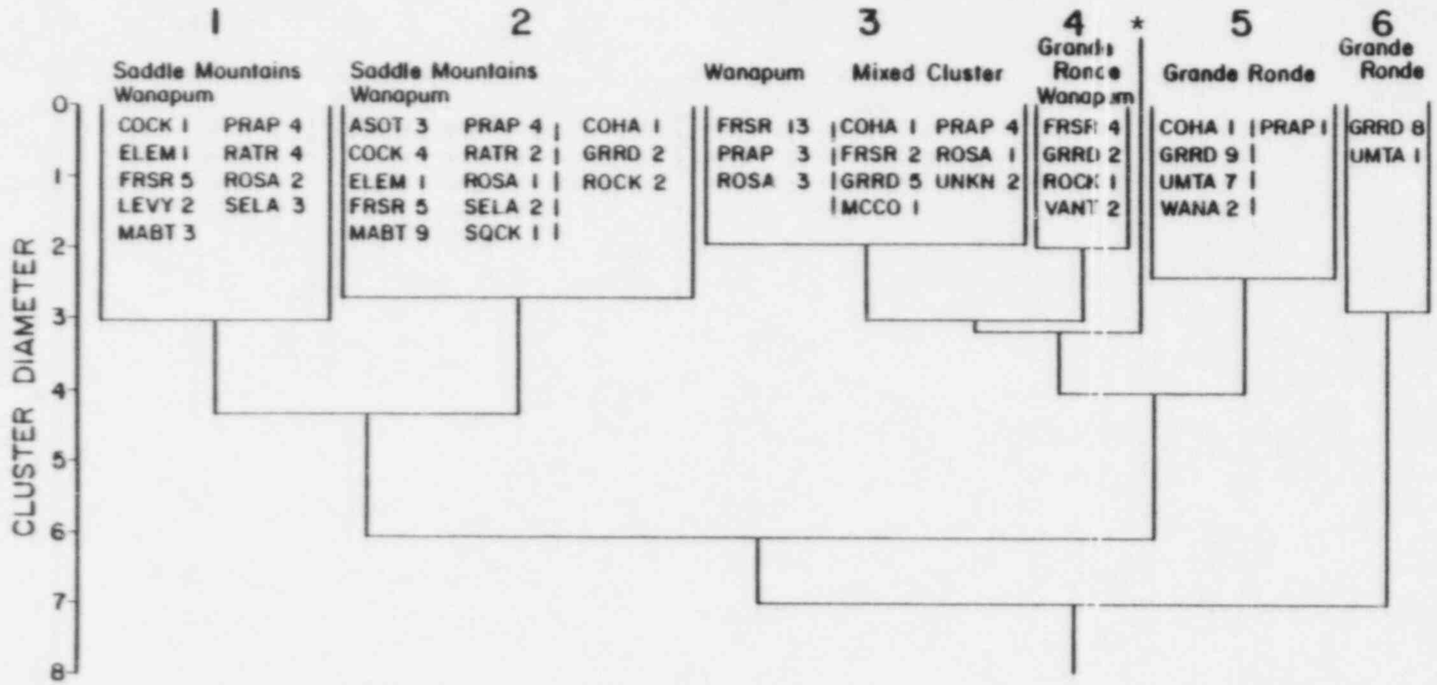
Complete data for chloride, magnesium, potassium, pH, and fluoride exist in 138 of the 146 observations. A cluster analysis of this larger data set using the approach described above identified six clusters instead of four (Figure 4.3.1). The additional two clusters are due in part to the additional samples and in part due to using five variables instead of twelve. The means of each of the five variables for each cluster are presented in Table 4.3.2.

Table 4.3.2. Group means[1] for the clusters of Fig. 4.3.1

CLUS	pH	CL	F	K	MG
1	7.93	1.782	0.433	2.219	2.071
2	8.67	2.301	0.998	2.608	0.362
3	9.42	4.407	2.459	2.846	0.125
4	8.99	5.930	3.046	3.319	0.111
5	9.59	5.230	3.137	2.276	0.077
6	9.78	4.839	3.408	1.422	0.057
TOTAL	8.89	3.498	1.814	2.467	0.619

1) ln (mg/l + 1) except pH

The first two clusters contain samples from the Saddle Mountain and Wanapum Formations. The two clusters have relatively low pHs and low chloride and fluoride levels. Cluster 1 is characterized also by samples that are high in magnesium. Cluster 2 contains five apparently anomalous samples from Grande Ronde Basalts. Clusters 5 and 6 reflect samples collected from greater depths. Cluster 6 contains nine Grande Ronde Formation samples and cluster 5 contains 17 samples that were obtained from the Grande Ronde Formation (out of 20 samples in the cluster). One Priest Rapids flow sample appears in cluster 5. It is a relatively shallow Wanapum sample compared to the other samples in cluster 5. It is treated as an anomaly in the



* unidentified formation by Rockwell

Figure 4.3.1. Cluster diagram (see Appendix A for formation code).

discussion below. The five means for cluster 4 indicate that it is a cluster high in chloride, fluoride, and potassium. It contains four Wanapum basalt samples and five Grande Ronde Basalt samples. Cluster 3 contains a cohesive group of 19 samples from the Frenchman Springs, Priest Rapids, and Rosa strata. It also contains a group of 16 samples from a variety of Wanapum and Grande Ronde samples mixed together indiscriminantly (labeled "mixed cluster" in Figure 4.3.1). This mixed group of samples is treated as an anomaly in the MANOVA, canonical analysis, and discriminant analysis discussed below. If one counts the unknown formation sample between clusters 4 and 5, 23 of the 138 samples are not clearly placed via the cluster analysis.

4.4 Confirmatory Analysis

The remaining (138 - 23 =) 115 samples were subjected to a stepwise MANOVA in order to identify the hydrochemical constituents most responsible for cluster differences and to test for differences among the clusters. The results appear in Table 4.4.1. MANOVA identifies the clusters as being significantly different, but clusters 3, 4, 5, and 6 are less so. A canonical analysis was used to identify a rotation of the five original axes (variables) to axes most aligned with differences among groups. The first two axes are associated with eigenvalues representing 89.4% of the eigenvalue total. A plot of the data using canonical axes 1 and 2 is presented in Figure 4.4.1.

Table 4.4.1 Summary of stepwise MANOVA on six clusters

Summary of action at each step

STEP	ACTION ENTERED	ACTION REMOVED	VARS IN	WILKS' LAMBDA	SIG.
1	CL		1	0.087955	0.0000
2	MG		2	0.017427	0.0
3	K		3	0.003938	0.0
4	PH		4	0.002801	0.0
5	F		5	0.002526	0.0

F Statistics and significances between pairs of groups
Each F statistic has 5 and 105.0 degrees of freedom.

GROUP	1	2	3	4	5
2	103.3				
3	184.3	69.1			
4	170.2	96.9	15.0		
5	253.6	140.6	20.4	24.4	
6	180.0	115.1	48.4	56.6	15.3

Each F is significant at the .0001 level.

The details of the canonical analysis are presented Table 4.4.2. Examination of the standardized discriminant function coefficients and the structure matrix facilitates interpretation of the canonical axes. A sample will have a high value on canonical axis 1 if it is high in chloride and fluoride, (relatively) high in pH, and low in magnesium. A sample will have a high value on canonical axis 2 if it is low in potassium and/or high in magnesium. The figure shows that in general water samples are organized into groups of samples from generally shallower basalt flows and from generally deeper basalt flows.

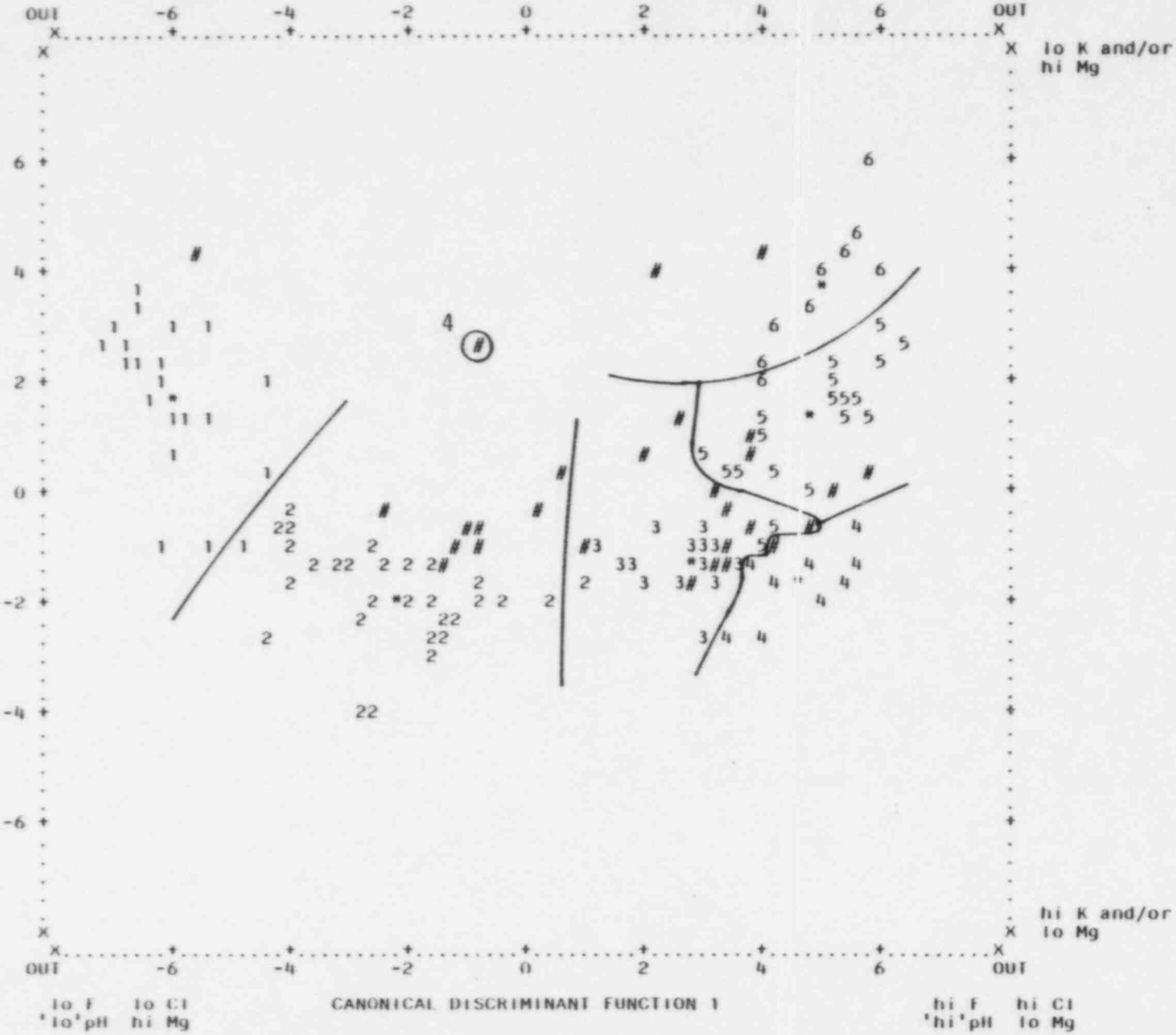


Figure 4.4.1. Map of six clusters plus unknowns in canonical space.

Table 4.4.2 Summary of canonical analysis on six clusters

CANONICAL DISCRIMINANT FUNCTIONS

Function	Eigenvalue	Percent of Variance	Cumulative Percent	Canonical Correlation
1*	19.31222	74.57	74.57	0.9750736
2*	3.84723	14.85	89.42	0.8908965
3*	2.63470	10.17	99.59	0.8513955
4*	0.09459	0.37	99.96	0.2939717
5*	0.01061	0.04	100.00	0.1024425

STANDARDIZED CANONICAL DISCRIMINANT FUNCTION COEFFICIENTS

	FUNC 1	FUNC 2	FUNC 3	FUNC 4	FUNC 5
PH	0.42623	0.01111	-0.09556	0.89781	-0.42809
CL	0.69226	0.23672	0.31356	-0.22120	-0.88815
F	0.22192	0.21374	0.26317	0.01665	1.15659
K	-0.10724	-0.74282	0.66476	0.22249	0.27754
MG	-0.39221	0.54455	0.74255	0.32962	0.08463

STRUCTURE MATRIX

	FUNC 1	FUNC 2	FUNC 3	FUNC 4	FUNC 5
CL	0.70672*	0.12083	0.49712	-0.41052	-0.26514
F	0.70173*	0.24751	0.11871	-0.01013	0.65736
K	0.03872	-0.80727*	0.58604	0.05759	0.00758
MG	-0.53694	0.58529*	0.54128	0.24244	-0.13179
PH	0.34864	0.01035	-0.22368	0.90959*	-0.03101

A discriminant analysis was conducted in order to place the 23 samples that were not placed clearly by the cluster analysis into one of the six clusters described above. The discriminant analysis also was used to place each of the 115 samples analyzed in the MANOVA-canonical analysis in order to check the discriminating power of the five variables. The incidence matrix is presented in Table 4.4.3. The boundary lines in Figure 4.4.1 were drawn using the results of the discriminant analysis. The boundaries visually confirm the tabular results listed in the incidence matrix. One sample in cluster 1 is designated as belonging to cluster 2. Similarly one

Table 4.4.3. Incidence matrix from the six cluster discriminant analysis.

ACTUAL GROUP		NO. OF CASES	PREDICTED GROUP MEMBERSHIP 1	2	3	4	5	6
GROUP	1	26	25 96.2%	1 3.8%	0 0.0%	0 0.0%	0 0.0%	0 0.0%
GROUP	2	33	0 0.0%	32 97.0%	1 3.0%	0 0.0%	0 0.0%	0 0.0%
GROUP	3	19	0 0.0%	0 0.0%	19 100.0%	0 0.0%	0 0.0%	0 0.0%
GROUP	4	9	0 0.0%	0 0.0%	0 0.0%	9 100.0%	0 0.0%	0 0.0%
GROUP	5	19	0 0.0%	0 0.0%	2 10.5%	0 0.0%	17 89.5%	0 0.0%
GROUP	6	9	0 0.0%	0 0.0%	0 0.0%	0 0.0%	1 11.1%	8 88.9%
UNGROUPED CASES		31	1 3.2%	9 29.0%	13 41.9%	2 6.5%	4 12.9%	2 6.5%

PERCENT OF "GROUPED" CASES CORRECTLY CLASSIFIED: 95.65%

cluster 2 sample is classified into cluster 3. All cluster 3 and 4 samples remain within their respective borders. Two cluster 5 samples fall within the cluster 3 region, but this placement probably is due to the unknown (anomalous) sample that occurs in the "cul de sac" of cluster 3 near the cluster 4-5 border. This sample is record number 128 which comes from an unknown formation in borehole DC-14. The discriminant analysis gives this sample a 0.45 probability of being in group 3 and a 0.42 probability of being from group 4. One cluster 6 sample is misplaced in cluster 5. Overall, the discriminant analysis correctly classifies 95.65% of the 115 samples.

In addition to the 23 set aside samples explained above, 8 samples were omitted from the cluster analysis because data were missing for one or more of the five variables. This total of 31 samples have group memberships as predicted in Table 4.4.4 and as detailed on Figure 4.4.1. Eighteen of the set of 23 samples not clearly placed in the cluster analysis are placed into the same groups as in the cluster analysis. Five of the 23 samples were not placed into the same clusters. Record number 178 appears in cluster 3; the discriminant analysis places it into cluster 5. Record number 180 appears in cluster 3; the discriminant analysis places it into cluster 4. The single sample clustered between clusters 3 and 4 is record number 205 from an unknown formation in borehole DC-2. It was discriminated as an isolated cluster 4 point (see Figure 4.4.1). It has a 0.46 probability of being in cluster 4 and a 0.35 probability of being in cluster 1. Visually it appears to be a cluster 2 point. This apparent singularity occurs because this sample has a value of 7.1 on canonical axis 3 which is not depicted in the

Table 4.4.4 Disposition of unknown (#) samples

Rec No	Formation	Borehole	Cluster	Fig 4.4.1	Fig 4.4.2
37	PRAP	DB-14	3	3	3-6
42	UMAT	DB-15	N/A	2	2
46	PRAP	DB-15	3	3	3-6
47	PRAP	DB-15	3	3	3-6
50	FRSR	DB-15	3	3	3-6
79	POMO	DC-1	N/A	2	2
86	COUM	DC-1	N/A	2	2
87	UMAT	DC-1	N/A	3	3-6
88	PRAP	DC-1	5	5	3-6
91	GRRD	DC-1	2	2	2
92	GRRD	DC-1	N/A	6	3-6
96	GRRD	DC-1	N/A	6	3-6
104	GRRD	DC-12	3	3	3-6
106	GRRD	DC-12	3	3	3-6
128	UNKN	DC-14	3	3	3-6
178	GRRD	DC-15	3	5	3-6
180	GRRD	DC-15	3	4	3-6
189	PRRZ	DC-16A	3	3	3-6
190	FRSR	DC-16A	3	3	3-6
202	MCCO	DC-16C	3	3	3-6
205	UNKN	DC-2	X	4	1
208	UNKN	DC-6	3	3	3-6
212	GRRD	DC-6	3	5	3-6
214	GRRD	DC-6	N/A	2	2
229	SBFL	DOE-17	N/A	1	1
242	GRRD	MCGEE	2	2	2
243	GRRD	MCGEE	2	2	2
244	GRRD	MCGEE	2	2	2
245	GRRD	MCGEE	2	2	2
250	PRAP	RRL-2	3	3	3-6
254	COHA	RRL-2	3	5	3-6

figure. Record numbers 212 and 254 appear in cluster 3 and were discriminated into cluster 5.

The confirmatory MANOVA above showed relatively less significance among clusters 3, 4, 5, and 6; consequently we performed another MANOVA-canonical analysis using clusters 1, 2, and a combined 3-4-5-6 cluster. The results appear in Tables 4.4.5 and 4.4.6 and Figure 4.4.2. Only magnesium, chloride, pH, and fluoride are required to differentiate the three groups. The average potassium levels do not vary greatly among them. The net result of this second MANOVA-canonical analysis-discriminant analysis is that one cluster 1 sample is confused with cluster 2 and vice-versa. One cluster 2 sample is predicted as combination cluster 3-4-5-6. All of the 3-4-5-6 samples were predicted as cluster 3-4-5-6. Irregular record number 205 shown in Figure 4.4.1 is predicted as a cluster 1 sample in this case; however, it is a distant point in cluster 1. Using this second canonical-discriminant analysis, group membership for the 31 unclearly clustered samples appears in the last column of Table 4.4.4.

4.5 Hydrogeologic Significance of Cluster Analysis

Several samples (record numbers) did not group in the expected cluster. For example, some samples which were obtained from the Grande Ronde Formation did not fall in the cluster with the rest of the Grande Ronde. The anomalous placement of these samples is discussed below with respect to their possible hydrogeologic significance. The record numbers of interest are 128 (borehole DC-14), 178 and 180 (borehole DC-15), 88 and 91 (borehole DC-1), 104 and 106 (borehole DC-12), 242, 243, 244, and 245 (McGee well),

Table 4.4.5 Summary of MANOVA- canonical analysis on three clusters

Summary of action at each step

STEP	ACTION ENTERED	ACTION REMOVED	VARS IN	WILKS' LAMBDA	SIG.
1	MG		1	0.115899	0.0
2	CL		2	0.028272	0.0
3	PH		3	0.020142	0.0
4	F		4	0.018597	0.0

F Statistics and significances between pairs of groups
Each F statistic has 4 and 109.0 degrees of freedom.

GROUP	1	2
2	131.79	
3	378.65	158.41

Each F is significant at the .0001 level.

CANONICAL DISCRIMINANT FUNCTIONS

Function	Eigenvalue	Percent of Variance	Cumulative Percent	Canonical Correlation
1*	14.39569	85.24	85.24	0.9669782
2*	2.49260	14.76	100.00	0.8447959

STANDARDIZED CANONICAL DISCRIMINANT FUNCTION COEFFICIENTS

	FUNC 1	FUNC 2
CL	0.66285	0.42514
MG	-0.54294	0.85375
PH	0.49376	0.12025
F	0.07367	0.41367

STRUCTURE MATRIX:

	FUNC 1	FUNC 2
F	0.63765*	0.43699
CL	0.61246*	0.51126
PH	0.37478*	0.02047
MG	-0.66674	0.70209*
K	-0.05695	-0.13998*

Table 4.4.6. Incidence matrix from the three cluster discriminant analysis.

ACTUAL GROUP	NO. OF CASES	PREDICTED GROUP MEMBERSHIP 1	2	3
GROUP 1	26	25 96.2%	1 3.8%	0 0.0%
GROUP 2	33	1 3.0%	31 93.9%	1 3.0%
GROUP 3	56	0 0.0%	0 0.0%	56 100.0%
UNGROUPED CASES	31	2 6.5%	9 29.0%	20 64.5%

PERCENT OF "GROUPED" CASES CORRECTLY CLASSIFIED: 97.39%

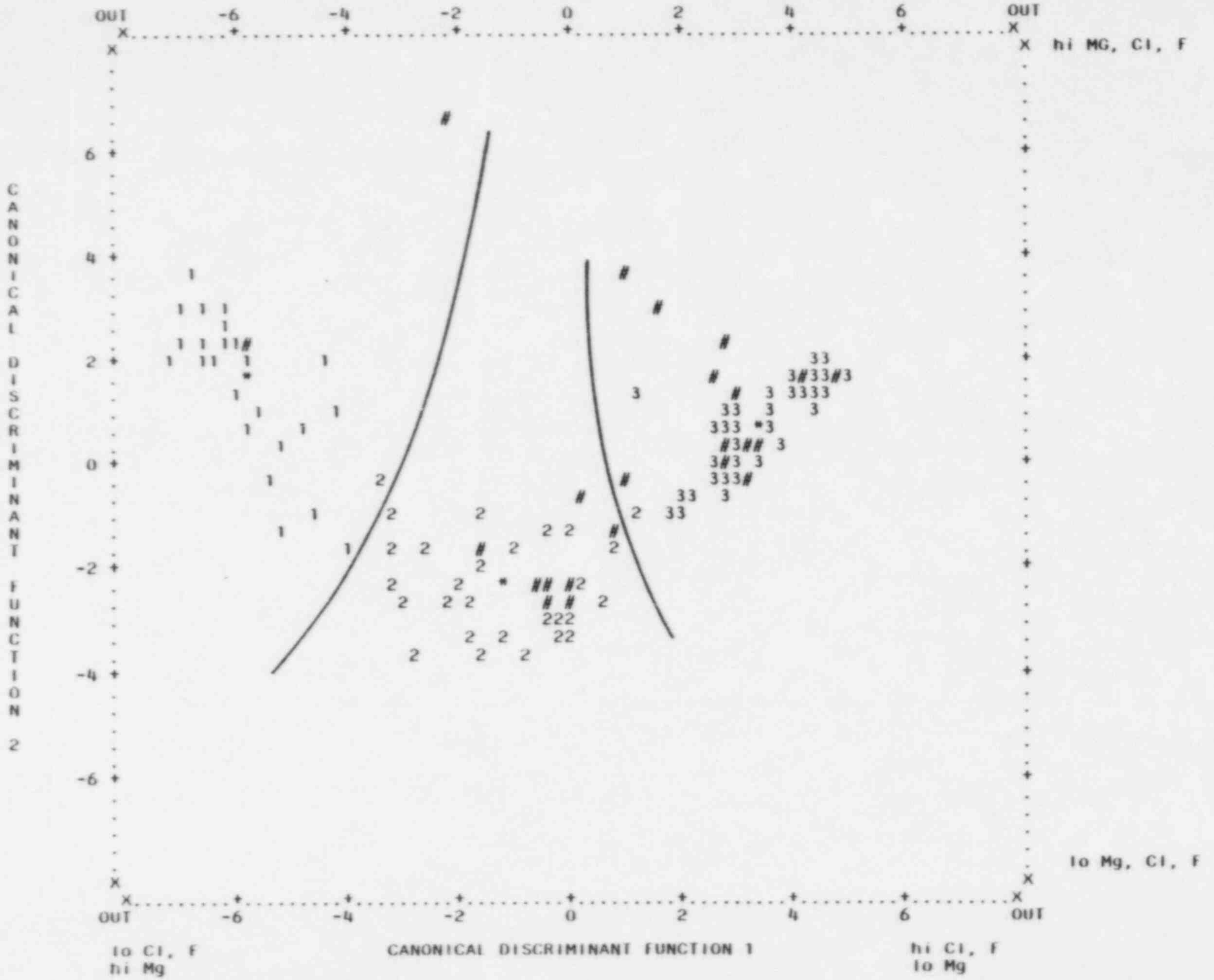


Figure 4.4.2. Map of three clusters plus unknowns in canonical space.

214 (borehole DC-6), and 205 (borehole DC-2).

Details about borehole DOE-17 are not available. Details about boreholes DC-1, DC-6, DC-12, DC-14, DC-15, and the McGee well are relevant to the consideration of the above analyses. Boreholes DC-6, DC-14, and DC-15 are located in close proximity to the Columbia River (Figure 3.1). Borehole DC-1 is located north of the 200 East Area. Borehole DC-12 is located southeast of the RRL and south of the 200 East Area. The McGee well is located between Umtanum Ridge and the RRL.

Borehole DC-14 is a flowing well that has been allowed to discharge over an extended period of time. A free flow discharge test was conducted in it to investigate the possibility of contamination of the groundwaters in the basalt flows by injection of drilling fluid. Record number 128, as discussed above, is a misplaced sample from a formation that the data base does not identify. Record number 128 predates this free flow discharge test. Record number 128 reportedly was extracted from a depth of 2,410 ft to 2,513 ft (735-766 meters). This depth should place the sample interval at the top of the Middle Sentinel Bluffs sequence (Figure 4.5.1) within the Grande Ronde Formation. Record number 132 was selected as a sample that represents the groundwaters at a deeper interval in the Grande Ronde Formation near the beginning of the free flow discharge test. Record number 166 collected near the end of the free flow discharge test was included in our analysis also. This sample (record number 166) is grouped appropriately in the Grande Ronde Formation cluster. Record number 132 is placed in the same cluster as record number 166 but much closer to record number 128. This difference in clustering of these three samples from the Grande Ronde

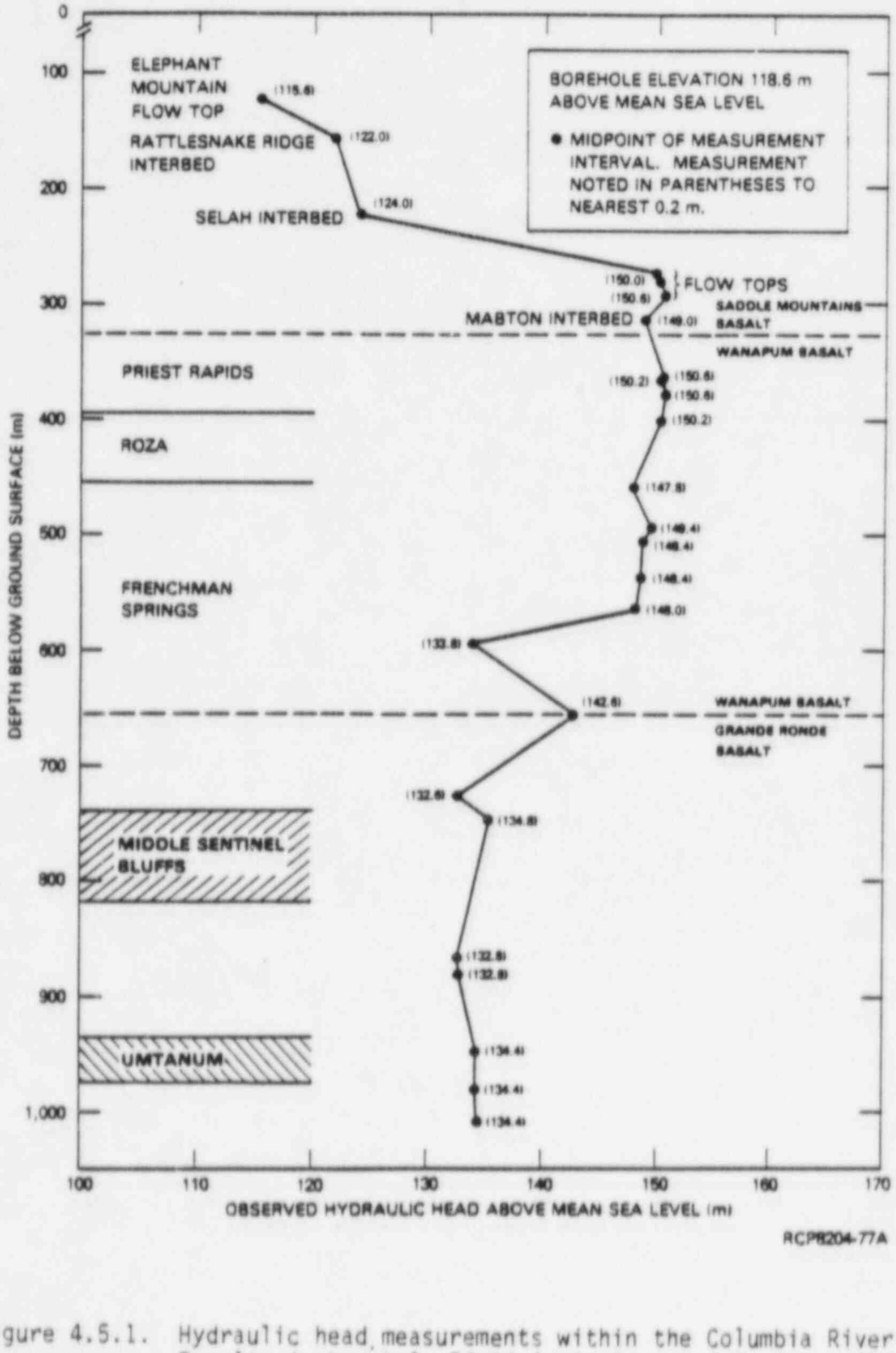


Figure 4.5.1. Hydraulic head measurements within the Columbia River Basalts in borehole DC-14 (U.S. Dept. of Energy, 1982, p. 5.1-69).

Formation collected at different times suggests that the record number 128 sample may not have been representative of the hydrochemistry of the Grande Ronde Formation. Record number 132 is not fully representative of the hydrostratigraphic unit whose quality was reflected by the later sample (record number 166) as a consequence of the free flow discharge test. The hydraulic head distribution from the drill and test sequence at borehole DC-14 indicates that a downward component of flow may exist (Figure 4.5.1). The hydraulic head data in this figure must be considered preliminary due to the short time intervals that were available during the testing of this borehole. The grouping of the later sample (record number 166) from the free flow discharge test is not consistent with a significant downward component of flow in the vicinity of borehole DC-14.

A hypothesis can be proposed and defended regarding the aforementioned anomalous grouping of record numbers 178 and 180 from borehole DC-15. These two samples were not placed in the expected Grande Ronde grouping with other Grande Ronde samples by our analysis. Borehole DC-15 is located near the Columbia River. The possibility exists that some vertically extensive oriented geologic structure exists in the vicinity of the Columbia River that permits vertical mixing of the groundwaters in this area. The hypothesis that there is vertical mixing of the groundwaters in the vicinity of the Columbia River is inconsistent with the concept that the Columbia River is a regional discharge sink. The concept that the river is a regional discharge sink requires that the groundwaters discharge upward. In the classical sense (homogeneous and isotropic hydraulic properties), all groundwater flow systems and hence flow paths must discharge upward to the

river. The upward discharge concept virtually eliminates the possibility of vertical mixing if the river is a regional line sink. The hydraulic head distribution within borehole DC-15 indicates that the overall potential for groundwater flow is upward within the formations tested. Several basalt flows appear to behave as hydraulic sinks based on these preliminary data (Figure 4.5.2). These data must be considered preliminary because a short time interval was allowed for head equilibration in the drill and test sequence employed at the site. Alternatively, the samples may not be representative of the true hydrochemistry of the Grande Ronde hydrostratigraphic unit sampled in this borehole. The samples may be contaminated by drilling fluids as evidenced in the previous discussion DC-14 samples.

Borehole DC-1 was drilled originally under the supervision of the U. S. Geological Survey under the identification number ARH-DC-1 in 1969. The samples in the data base are from the original U. S. Geological Survey work. Gephart et al (1979, p. III-170) state that "The significant level of drilling fluid contamination within the aquifer waters analyzed, as noted by LaSala and Doty (1971) and the degree to which cross-aquifer communication took place within the borehole make any quantitative interpretation of these data highly suspect." Our statistical analysis apparently detected this contamination and/or cross-aquifer communication and could not fit the samples properly.

Borehole DC-12 is located near the projected axis of the Benson Ranch Syncline (Figure 4.5.3). Tectonic stresses associated with folding usually are assumed to create the greatest possibility of fracturing near the axis

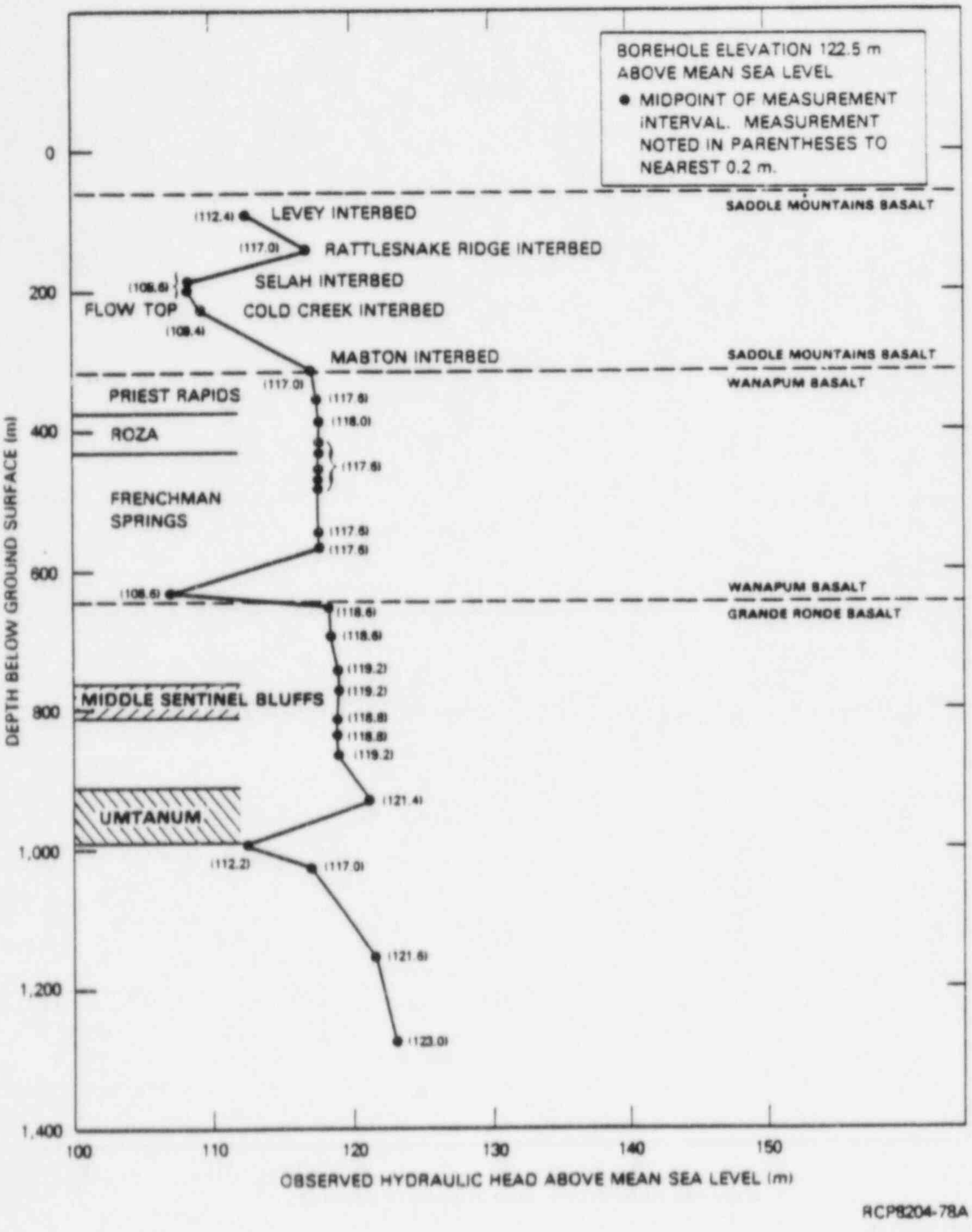


Figure 4.5.2. Hydraulic head measurement within the Columbia River Basalts in borehole DC-15 (U.S. Dept. of Energy, 1982, p. 5.1-70).

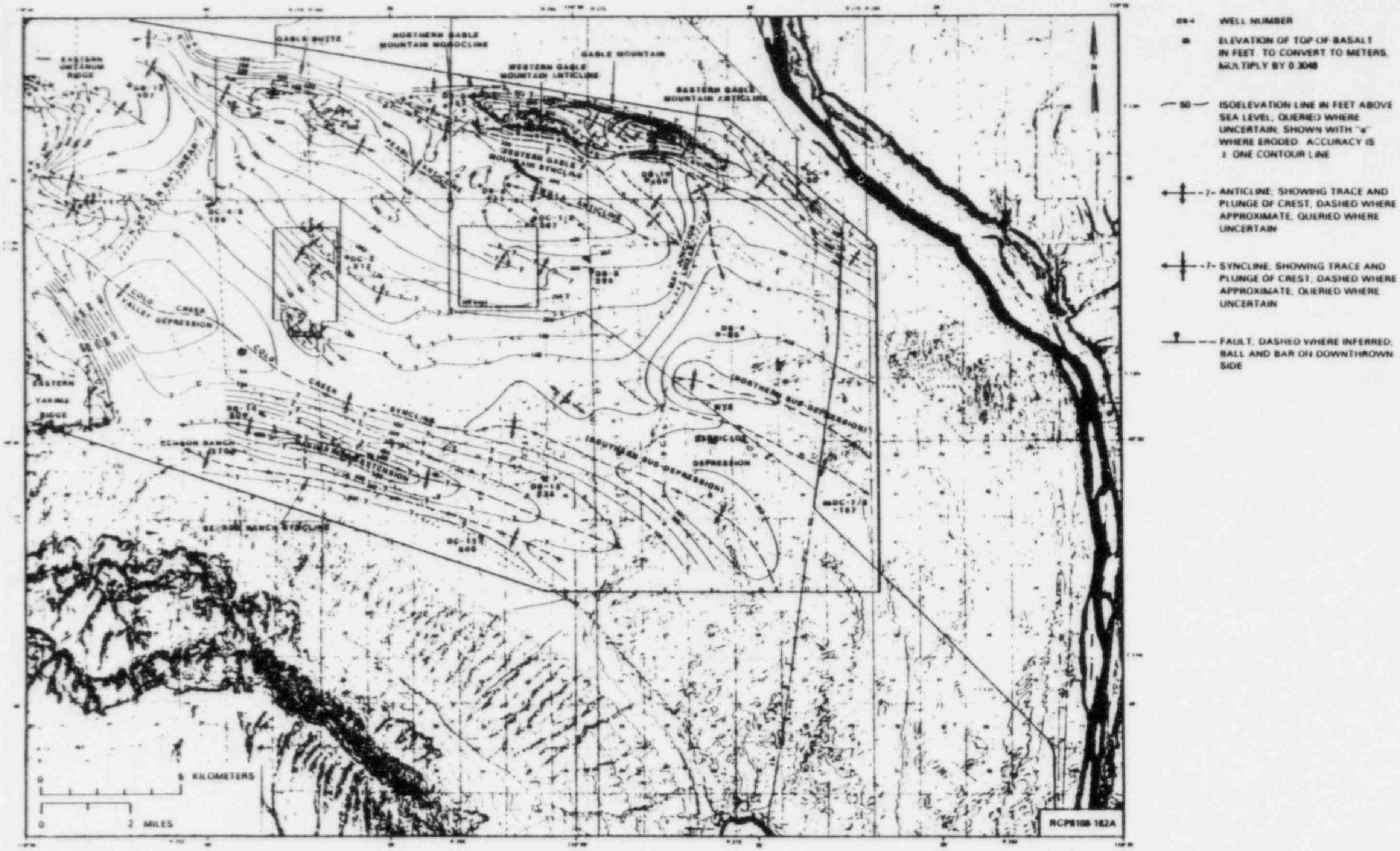


Figure 4.5.3. Top-of-basalt contour map (U.S. Dept. of Energy, 1982, p. 3.7-27).

of a syncline or anticline. The data suggest that the record numbers 104 and 106 represent a shallower water than what was sampled in borehole DC-12 from the Grande Ronde Basalts. The samples may indicate the vertical mixing of groundwaters in the vicinity of this borehole, possibly due to the influence of the stresses and associated fracturing near the synclinal axis. Figure 4.5.4 illustrates the concept that vertical mixing may occur in the vicinity of borehole DC-12. The distribution of hydraulic head in this borehole is essentially constant with depth; the differences in hydraulic heads measured in this borehole are within the range of possible measurement error. As noted previously, these data must be considered preliminary due to testing procedures employed at the BWIP site.

The deepened McGee well has been sampled within the Grande Ronde Formation since the completion of the report by Williams and Assoc., Inc. (1983). The record numbers 242 through 245 from this well do not fall within the Grande Ronde cluster even though the samples were collected from the Grande Ronde Formation. These samples fall in the Saddle Mountains-Wanapum cluster 2. The McGee well lies to the northwest of the so called Cold Creek "Barrier" which has been postulated on the basis of water level data, hydrogeologic pump test data, and geophysical data. The Cold Creek "Barrier" is indicated on Figure 4.5.3 as "N 96 to N 84 linear". The Cold Creek Barrier is the new designation for this postulated feature (U. S. Dept. of Energy, 1984, p. 3-79). It has been referred to previously as the Y Barricade and/or the Nancy Linear. The data discussed herein suggest that the Grande Ronde Formation groundwaters are different to the west and to the east of this feature.

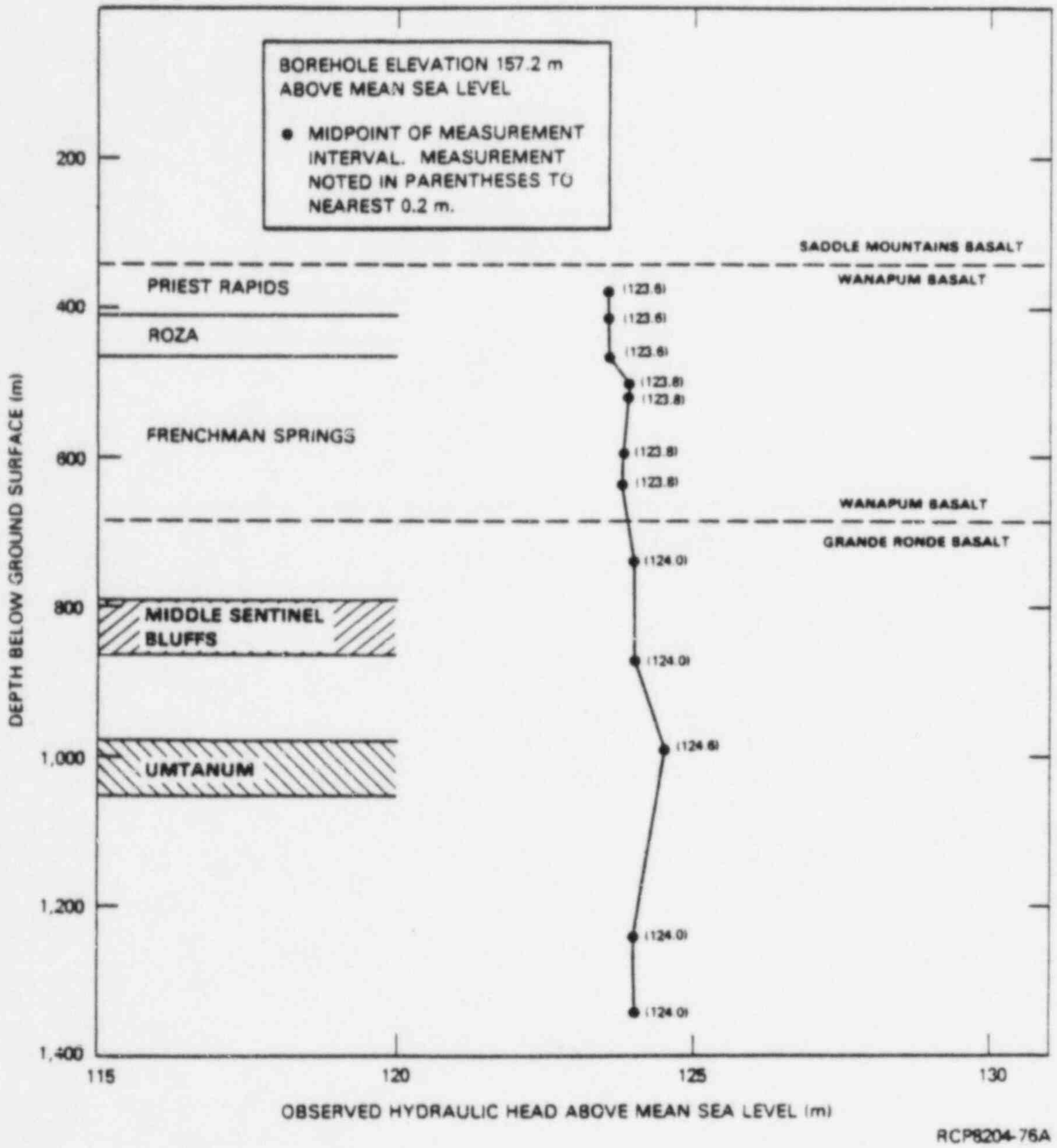


Figure 4.5.4. Hydraulic head measurements within the Wanapum and Grande Ronde Basalts in borehole DC-12 (U.S. Dept. of Energy, 1982, p. 5.1-68).

Record number 214 (borehole DC-6) does not group with the Grande Ronde cluster 6 as it should. This sample falls in cluster 2 which is characteristic of shallower Saddle Mountains and Wanapum Formation samples. No obvious explanation for this anomaly is apparent. The preliminary hydraulic head distribution (Figure 4.5.5) in this borehole does not support the concept that there is a significant downward component of groundwater flow in the vicinity of this borehole. The general direction of groundwater flow in this borehole is upward. As previously stated, these data must be considered preliminary. It is possible that this sample is not representative of Grande Ronde Formation waters due to inadequate borehole development. Vertical groundwater mixing does not seem probable because other Grande Ronde samples from this borehole cluster in or near cluster 5 as they should.

Record number 205 is from borehole DC-2 which is 60 feet southwest (at ground surface) of borehole DC-1. This hole was cored in basalt between May and September of 1977. The borehole was left open (uncased) between depths of 2,200 and 3,300 feet below ground surface (Gephart et al, 1979, p. III-116). Figure III-29 (Gephart et al, 1979) indicates that this depth interval is within the Grande Ronde Basalts. The 1979 sampling was, in all probability, from the Grande Ronde Basalts. A plausible explanation for the anomalous grouping of this sample is not clear. It is possible that contaminating fluids from drilling still remained in the vicinity of the borehole 2 years later.

Additional explanations must be considered for the anomalous grouping of these samples. For example the anomalous grouping may be the result of

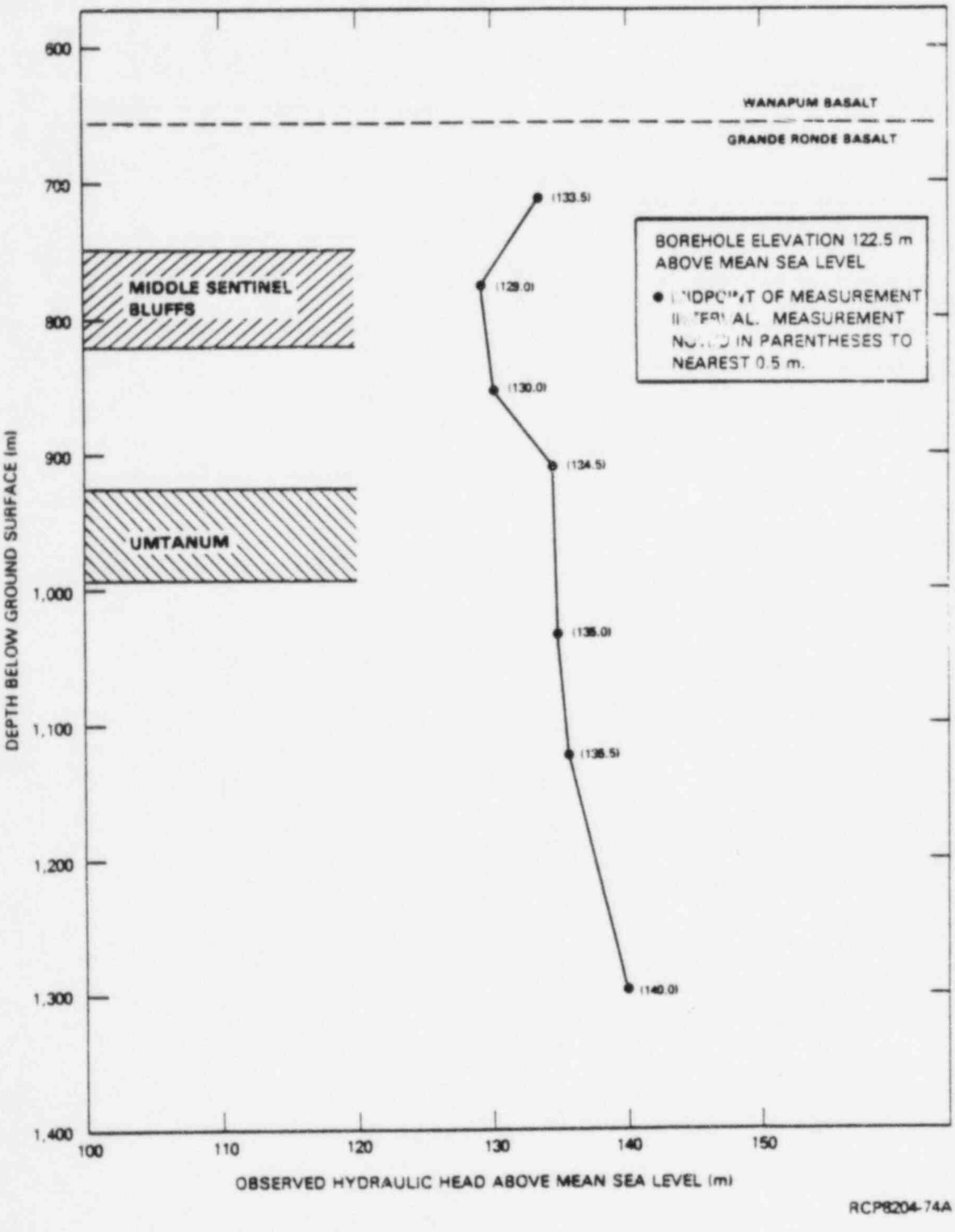


Figure 4.5.5. Hydraulic head measurements within the Grande Ronde Basalt in borehole DC-6 (U.S. Dept. of Energy, 1982, p. 5.1-66).

incorrectly identified samples. On the other hand the samples may have been correlated incorrectly with respect to depth, borehole number, and basalt flow sampled. In some cases the anomalous samples may have been contaminated by drilling fluids or the samples may not be representative of the hydrochemistry of the flow due to extensive periods of time during which the borehole was left open to cross formational flow. Sampling and analysis procedures may have resulted in inaccurate concentrations which normally could be detected by calculating an ion balance for each sample. An ion balance could not be calculated for this sample set because two major ions were not measured (presented).

5. DISCUSSION

In general, hydrochemistry data for the BWIP Site basalts can be used to distinguish formations statistically. The ability to distinguish the formations from which the water samples were derived is based on the distinctness of the hydrochemistry of these groundwaters. This distinctness should not be construed as being synonymous with hydraulic isolation. Two clusters of samples can be identified for the shallow basalts. The hydrochemistry of both clusters is characterized by low pH, low chloride (Cl), and low fluoride (F) concentrations. The clusters differ with respect to magnesium (Mg) concentrations. Cluster 1 typically has high magnesium concentrations compared to cluster 2; cluster 2 is slightly higher in magnesium concentrations than the concentrations in clusters containing deeper samples.

Clusters 5 and 6 represent samples from Grande Ronde Basalts. Clusters 3 and 4 are intermediate between clusters 1 and 2 and clusters 5 and 6. The Saddle Mountains and Grande Ronde samples are reasonably distinct except for the McGee samples discussed previously. These findings lend empirical support to hypothesis A2. That is, statistical procedures can distinguish among basalt formations at the BWIP site when applied to hydrochemical data.

The samples do not cluster in an areal spatial sense. This general conclusion is drawn from the spatial distribution of samples in the clusters. However the area to the west of the so called (or proposed) Cold Creek Barrier, which currently is represented only by the McGee well samples constitute a possible exception to this statement. No other samples are available from this area to support or refute the possibility of this

exception. This anomaly should be investigated further if more data become available. The statistical approach used herein may have identified an impact of the proposed Cold Creek Barrier on hydrochemistry. With this exception, hypothesis B1 is supported over hypothesis B2.

Several hydrogeologic implications are apparent from this analysis. The groundwaters in the Grande Ronde Basalts appear to exhibit a significant statistical difference on either side of the proposed Cold Creek Barrier. The anomalous placement of samples from borehole DC-12 in clusters suggests that vertical groundwater mixing occurs in the vicinity of borehole DC-12. The anomalous placement of the borehole DC-14 sample (record number 128) supports the conclusion that for some unknown reason the groundwater sample was not representative of the true groundwater quality of the formation from which it was collected.

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APPENDIX A
Computer Coding for Geologic Units

COMPUTER CODING FOR GEOLOGIC UNITS

Geologic unit or sampling designation	Computer code
Levey Interbed	LEVY
Elephant Mountain	ELEM
Rattlesnake Ridge Interbed	RATR
Selah Interbed	SELA
Cold Creek Interbed	COCK
Asotin	ASOT
Huntzinger	HUNT
Huntzinger #1	HUN1
Asotin-Umatilla	ASUM
Umatilla	UMAT
Umatilla #2	UMA2
Umatilla (annulus)	UMAA
Mabton Interbed	MABT
Mabton 0 Interbed	MABO
Priest Rapids (top)	PRRT
Priest Rapids #1	PRA1
Priest Rapids #2	PRA2
Priest Rapids-Roza	PRRZ
Priest Rapids	PRAP
Priest Rapids (annulus)	PRAA
Priest Rapids (packed)	PRPK
Roza Flow top	ROZT
Roza	ROZA
Roza-Frenchman Springs	RZFS
Squaw Creek Interbed	SQCK
Frenchman Springs #2	FRS2
Frenchman Springs #3	FRS3
Frenchman Springs #4	FRS4
Frenchman Springs #5	FRS5
Frenchman Springs #6	FRS6
Frenchman Springs #7	FRS7
Frenchman Springs #8	FRS8
Frenchman Springs	FRSR
Vantage Interbed	VANT
Sentinel Bluffs (top)	SENT
Sentinel Bluffs (bottom)	SENB
Grande Ronde	GRRD
Grande Ronde #2	GRR2
Grande Ronde #4	GRR4
Grande Ronde #6	GRR6
Grande Ronde #7	GRR7
Grande Ronde #8	GRR8

Grande Ronde #10	GR10
Grande Ronde #11	GR11
Grande Ronde Um	UMTA
Grande Ronde (lower)	GRRL
Grande Ronde (lower-composite)	GRLC
Grande Ronde (upper)	GRRU
Umtanum	UMTA
Umtanum (top)	UMTT
Umtanum (lower)	UMTL
Umtanum (bottom)	UMTB
N2R2 (high transmissivity)	N2R2

NEW UNIT DESIGNATIONS

Gable Mtn/Cold Creek	GACO
Cold Creek/Umatilla	COUM
Wanapum	WANA
Rocky Coulee top	ROCT
Rocky Coulee	ROCK
Rocky Coulee bottom	ROCB
Cohassett top	COHT
Cohassett	COHA
Cohassett bottom	COHB
McCoy Canyon	MCCO

APPENDIX B
Concentration Data for Selected Dissolved Ions plus pH and TDS in Groundwater Samples from the BWIP Site

The following abbreviations are used in the data listing.

OBS = Observation number
SAMPLE = BWIP sample number
FORM = Formation
RECNO = Record number

The remaining abbreviations are chemical symbols.

OBS	SAMPLE	FORM	RECNO	PH	SC	F_ALK	CL	F	SO4	NA	K	CA	MG	SI	TOTC	AL
1	CP73	MABT	2	8.36	401.0	202.0	16.0	3.1	0.5	94.8	12.7	2.00	0.550	31.8	47.37	-0.05
2	CP82	MABT	2	8.39	389.0	208.0	16.2	3.1	0.5	96.9	13.0	1.30	0.410	30.9	.	-0.05
3	81-19	MABT	4	8.24	438.0	191.0	16.1	3.6	0.3	100.6	13.2	1.80	0.490	27.9	.	-0.01
4	82-27	PRAP	5	8.67	473.0	186.0	46.6	7.1	16.3	99.7	15.3	0.43	0.100	35.4	.	-0.08
5	82-87	PRAP	5	8.67	473.0	186.0	47.5	7.1	16.6	100.2	15.3	0.49	0.100	35.3	.	-0.08
6	81-57	PRAP	11	8.19	277.0	141.0	4.6	0.7	.	33.3	9.9	15.30	7.500	32.2	.	0.04
7	63-95	SELA	12	8.05	320.0	145.0	4.6	0.0	19.1	16.8	7.1	25.30	13.500	14.9	.	-0.02
8	CP66	MABT	14	8.27	335.0	159.0	6.6	0.4	15.8	36.0	7.9	20.10	11.880	26.3	37.51	0.11
9	CP67	PRAP	16	8.23	315.0	162.0	5.0	0.6	0.5	33.0	10.7	17.70	10.290	26.1	38.99	0.09
10	CP69	ELEM	18	8.29	320.0	153.0	4.1	0.4	18.9	18.5	6.2	32.20	12.400	28.2	35.93	-0.02
11	CP72	RATR	21	8.05	300.0	150.0	3.7	0.4	7.6	26.7	7.2	21.60	9.250	28.6	35.54	0.11
12	CP91	SELA	22	8.35	262.0	160.0	3.7	0.6	6.5	62.5	8.8	6.40	1.230	29.3	37.59	1.60
13	CP92	COCK	23	8.28	306.0	170.0	3.9	0.5	0.6	63.9	14.7	10.90	0.950	31.2	39.88	0.14
14	CP97A	MABT	27	7.25	315.0	161.6	4.6	0.1	2.3	64.2	11.9	10.50	2.710	26.8	.	-0.02
15	CP97B	MABT	27	7.40	313.0	161.6	4.6	0.1	2.3	63.6	11.5	10.30	2.680	26.5	.	-0.02
16	CP93	RATR	29	8.41	388.0	152.0	5.4	0.3	38.6	17.0	6.4	42.00	15.750	31.3	35.34	0.14
17	CP94	RATR	29	8.42	367.0	152.0	5.2	0.3	39.7	17.1	6.4	42.90	15.930	31.7	.	0.13
18	CP98	SELA	30	8.40	289.0	159.0	3.3	0.2	6.5	32.5	7.2	20.10	7.690	29.1	.	0.78
19	CP101	COCK	33	8.66	271.0	150.0	3.7	0.4	0.7	40.6	7.8	14.02	5.200	28.0	33.60	0.02
20	CP103	MABT	36	8.01	303.0	159.0	10.9	0.1	2.4	67.9	10.0	2.17	0.710	29.7	37.74	0.32
21	81-139	PRAP	37	9.31	714.0	128.4	129.9	9.5	-0.5	136.7	17.6	2.03	-0.025	36.2	.	0.03
22	81-162	PRAP	37	9.31	714.0	128.4	129.0	9.4	-0.5	130.9	16.4	1.91	-0.025	36.6	24.31	0.00
23	79-17	RATR	38	7.00	335.0	125.9	7.7	-0.3	37.1	44.4	10.4	18.90	4.900	25.0	.	-0.01
24	79-22	RATR	38	7.00	317.8	98.4	.	.	.	.	.	.	.	.	.	.
25	79-4	RATR	38	7.80	340.0	127.0	7.8	-0.3	39.7	42.0	11.6	19.60	5.100	26.0	.	0.04
26	79-20	SELA	39	7.80	327.0	171.5	3.5	0.9	-1.2	78.4	7.1	2.36	0.390	20.7	.	-0.01

OBS	BA	B	CO	CR	CU	FE	LI	MN	MO	NI	PB	SR	ZN
1	0.013	0.206	-0.010	-0.005	-0.005	0.178	.	-0.100	-0.10	.	.	.	-0.005
2	0.012	0.089	-0.010	-0.005	-0.005	0.363	.	-0.100	-0.10	.	.	.	-0.005
3	0.010	0.130	-0.010	-0.003	-0.002	0.050	-0.020	-0.100	-0.03	-0.020	-0.010	0.010	-0.002
4	0.010	0.210	-0.020	-0.036	-0.006	0.120	0.015	-0.003	0.10	-0.030	-0.150	0.002	-0.020
5	0.010	0.200	-0.020	-0.036	-0.006	0.130	0.014	-0.003	0.10	-0.030	-0.150	0.002	-0.020
6	0.023	0.030	-0.010	0.004	-0.002	0.110	.	0.340	0.13	-0.020	-0.100	0.060	0.070
7	0.043	0.022	0.020	-0.005	-0.005	-0.005	.	.	-0.02	.	.	.	-0.005
8	0.065	0.034	-0.020	-0.005	-0.005	0.232	.	0.057	-0.02	.	.	.	0.037
9	0.052	0.013	-0.020	-0.005	-0.005	0.181	.	0.044	-0.02	.	.	.	0.015
10	0.118	-0.005	-0.005	-0.005	-0.005	0.033	.	0.070	-0.01	.	.	.	0.048
11	0.146	-0.005	-0.005	-0.005	-0.005	1.367	.	0.060	0.13	.	.	.	0.050
12	0.045	-0.005	-0.010	-0.005	0.010	2.755	.	0.100	0.10	.	.	.	-0.005
13	0.540	-0.005	-0.020	-0.005	-0.005	0.119	.	-0.500	0.07	.	.	.	-0.005
14	0.030	-0.005	-0.020	-0.005	-0.005	0.164	.	.	-0.02	.	.	.	-0.005
15	0.030	-0.005	-0.020	-0.005	-0.005	0.164	.	.	-0.02	.	.	.	-0.005
16	0.034	-0.005	-0.020	-0.005	.	-0.005	.	-0.500	0.13	.	.	.	0.018
17	0.038	-0.005	-0.020	-0.005	-0.005	-0.005	.	-0.500	0.10	.	.	.	0.015
18	0.031	0.019	-0.020	-0.005	-0.005	0.760	.	0.062	-0.02	.	.	.	0.129
19	0.023	0.032	-0.020	-0.005	-0.005	0.093	.	0.036	-0.02	.	-0.020	.	0.109
20	0.023	0.040	-0.020	-0.005	-0.005	0.734	.	-0.010	-0.02	.	-0.020	.	0.093
21	0.006	0.530	-0.004	-0.006	-0.003	0.160	0.002	0.008	0.11	-0.008	-0.043	0.007	0.003
22	0.004	0.530	-0.004	-0.006	-0.003	0.170	0.003	0.007	0.11	-0.008	-0.043	0.007	0.006
23	0.110	-0.005	-0.010	.	-0.002	0.018	-0.020	-0.020	.	-0.020	-0.100	.	.
24	.	.	.	.	.	.	.	.	.	.	.	.	.
25	0.120	.	.	.	.	0.024	.	-0.020	.	.	.	.	.
26	0.020	-0.005	-0.010	-3.000	-0.002	0.050	-0.020	-0.020	-0.03	-0.020	-0.100	0.120	0.060

OBS	SAMPLE	FORM	RECNO	PH	SC	F_ALK	CL	F	SO4	NA	K	CA	MG	SI	TOTC	AL
27	79-35	SELA	39	8.10	332.0	173.0	3.4	0.8	-1.2	78.5	7.1	2.40	0.390	20.0	.	-0.01
28	79-27	COCK	40	8.10	370.0	174.0	7.2	3.0	-1.2	82.7	8.7	2.00	0.390	31.6	.	-0.01
29	79-33	COCK	40	8.10	380.0	174.2	7.4	3.0	-1.2	87.3	8.7	2.00	0.400	25.6	.	-0.01
30	79-15	ASUM	41	8.20	382.0	191.3	8.8	3.0	-1.2	89.9	10.6	1.60	0.460	29.4	.	0.33
31	79-46	ASUM	41	8.20	382.0	191.3	9.4	2.9	-1.2	90.7	10.6	1.63	0.470	29.7	.	0.33
32	79-8	UMAT	42	8.70	427.5	207.7	.	.	.	97.6	10.8	1.90	0.470	28.8	.	0.37
33	79-74	PRAP	46	9.67	715.0	156.7	105.1	19.0	9.6	178.8	15.4	2.98	0.820	57.8	.	1.38
34	79-85	PRAP	46	9.67	798.2	156.6	105.5	19.1	10.2	176.0	15.6	3.04	0.550	59.0	.	1.47
35	79-80	PRRZ	47	9.63	850.0	149.0	104.8	19.0	6.8	170.8	14.9	2.00	0.300	58.0	.	0.45
36	79-99	PRRZ	47	9.63	850.0	149.6	104.6	19.0	6.8	170.1	14.7	1.90	0.300	57.2	.	0.60
37	79-62	FRSR	48	9.38	741.6	146.8	97.8	16.9	20.1	155.0	14.5	2.20	0.240	41.0	.	0.14
38	79-84	FRSR	48	9.38	741.6	146.8	98.0	17.0	20.1	159.6	17.0	2.40	0.300	40.3	.	0.07
39	80-35	FRSR	50	9.41	747.1	158.6	109.0	18.4	16.3	169.7	18.6	4.30	2.200	94.5	.	10.60
40	80-41	FRSR	50	9.41	747.1	158.6	103.0	18.0	16.5	169.0	18.1	3.90	2.000	85.4	.	9.10
41	80-24	FRSR	51	9.53	758.8	154.2	111.0	19.5	17.8	162.9	19.3	1.30	0.060	46.6	.	-0.01
42	80-74	FRSR	51	9.53	758.8	154.2	108.0	19.3	17.5	158.5	19.2	1.30	0.060	47.5	.	-0.01
43	80-42	FRSR	52	9.36	737.3	168.6	102.0	17.4	18.4	161.9	19.2	1.40	0.190	45.0	.	0.02
44	80-77	FRSR	52	9.36	737.3	168.6	101.0	17.6	18.7	160.6	18.3	1.40	0.180	44.3	.	0.01
45	80-1	FRSR	53	9.44	764.4	148.2	105.0	19.8	9.4	164.2	17.7	1.30	0.110	45.6	.	0.03
46	80-51	FRSR	53	9.44	764.4	148.2	105.3	19.5	9.4	164.5	17.6	1.20	0.100	46.0	.	-0.01
47	81-11	PRAP	58	8.43	463.0	134.2	29.9	5.1	35.7	98.7	17.0	0.73	0.290	29.6	.	0.20
48	81-13	PRAP	58	8.43	463.0	134.2	29.7	5.1	35.6	99.4	17.3	0.75	0.360	29.7	.	0.20
49	81-10	ROZA	59	8.67	496.0	134.2	31.9	5.8	38.2	103.4	16.3	0.59	0.090	34.2	.	0.07
50	81-7	ROZA	59	8.67	496.0	134.2	31.9	5.8	38.5	104.5	16.5	0.60	0.090	34.3	.	0.09
51	CP116	MABT	63	8.40	390.0	182.0	6.4	1.1	1.1	77.8	10.6	0.56	0.160	48.6	.	0.10
52	CP117	MABT	63	8.30	405.0	175.0	7.2	0.6	-1.2	84.8	11.6	0.60	0.180	50.5	.	0.12

OBS	BA	B	CO	CR	CU	FE	LI	MN	MO	NI	PB	SR	ZN
27	0.020	-0.005	-0.010	-0.003	-0.002	0.050	.	-0.020	-0.03	-0.02	-0.10	.	0.060
28	-0.005	0.114	0.025	0.045	.	0.156	.	-0.020	0.98	.	-0.10	.	.
29	-0.005	0.114	.	.	.	0.140	.	-0.020	0.98	.	.	.	.
30	0.260	0.110	0.050	0.080	0.050	0.180	-0.02	0.060	0.27	0.03	0.29	0.060	0.060
31	0.265	0.110	0.050	0.080	0.060	0.200	-0.02	0.060	0.31	0.04	0.34	0.060	0.060
32	0.260	0.090	0.050	0.070	0.053	0.240	-0.02	0.060	0.21	0.02	0.30	0.059	0.060
33	0.097	1.270	-0.010	-0.003	-0.002	3.280	.	0.050	0.50	.	.	.	0.100
34	0.046	1.300	-0.010	-0.003	-0.002	3.320	-0.02	0.060	0.60	-0.02	-0.10	0.013	0.200
35	-0.005	1.300	-0.010	-0.003	-0.002	1.700	.	0.030	-0.03	.	.	.	0.040
36	-0.005	1.270	-0.010	0.020	-0.002	2.400	.	0.040	0.50	.	.	.	0.050
37	0.034	0.900	-0.010	0.020	0.020	0.320	-0.02	0.290	-0.03	-0.02	-0.10	0.011	0.080
38	0.150	0.960	-0.010	0.020	0.030	0.190	-0.02	0.280	0.[illegible]	-0.02	-0.10	0.011	0.080
39	0.200	0.910	-0.010	0.020	-0.002	6.300	-0.02	0.130	-0.03	-0.02	-0.10	0.016	0.600
40	0.160	0.870	-0.010	0.020	0.010	5.600	-0.02	-0.020	0.30	-0.02	0.12	0.015	0.620
41	-0.005	0.950	-0.010	-0.003	-0.002	0.090	-0.02	-0.020	-0.03	-0.02	0.12	-0.001	0.040
42	-0.005	0.910	-0.010	-0.003	0.100	0.100	-0.02	-0.020	-0.03	-0.02	0.14	-0.001	0.010
43	-0.005	0.820	-0.010	-0.003	-0.002	0.080	-0.02	-0.020	0.20	-0.02	-0.10	0.007	0.020
44	-0.005	0.810	-0.010	-0.003	-0.002	0.080	-0.02	-0.020	-0.03	-0.02	-0.10	0.007	0.020
45	0.016	1.300	-0.010	-0.003	-0.002	0.270	-0.02	-0.020	-0.03	-0.02	-0.10	0.006	-0.010
46	-0.005	1.300	-0.010	-0.030	-0.002	0.110	-0.02	-0.020	0.30	-0.02	-0.10	0.005	-0.010
47	0.190	0.150	-0.010	0.010	0.009	0.680	.	0.370	0.27	-0.01	-0.10	0.004	0.030
48	0.200	0.150	-0.010	0.005	-0.005	0.690	.	0.400	0.28	-0.01	-0.10	0.004	0.030
49	0.220	0.140	-0.010	0.004	-0.005	0.130	.	0.340	0.26	-0.01	-0.10	0.002	0.020
50	0.190	0.150	-0.010	0.005	0.005	0.130	.	0.370	0.24	-0.01	-0.10	0.003	0.020
51	2.800	0.190	-0.010	-0.003	0.024	1.980	.	-0.024	-0.03	.	.	.	0.100
52	-0.005	0.160	-0.010	-0.003	0.010	2.300	.	-0.020	-0.03	.	.	.	0.090

SAS 10:22 THURSDAY, MARCH 28, 1985

OBS	SAMPLE	FORM	RECNO	PH	SC	F_ALK	CL	F	SO4	NA	K	CA	MG	SI	TOTC	AL
53	CP113	MABT	66	8.00	385.0	187.7	40.3	2.1	-1.2	98.4	14.6	1.40	0.430	0.0	.	0.19
54	83-472	MABT	72	8.50	311.0	139.0	10.1	0.8	14.4	71.0	10.5	0.45	-0.100	27.4	.	-0.08
55	DC-5	POMO	79	.	314.0	122.0	11.0	0.5	19.0	60.0	8.8	4.70	1.200	11.0	.	0.10
56	DC-7	GACO	85	8.60	344.0	180.0	4.2	1.0	.	79.0	7.8	2.10	0.300	21.0	.	0.10
57	DC-8	COUM	86	.	402.0	192.0	13.0	1.7	.	90.0	9.9	1.70	0.400	26.0	.	0.10
58	DC-9	UMAT	87	.	552.0	182.0	49.0	7.5	1.6	114.0	14.0	1.70	0.400	27.0	.	0.40
59	DC-10	PRAP	88	9.70	773.0	157.0	120.0	16.0	2.0	164.0	10.0	0.90	0.400	42.0	.	.
60	DC-11	WANA	89	10.50	904.0	153.0	120.0	20.0	10.0	177.0	12.0	5.80	0.100	42.0	.	1.10
61	DC-12	WANA	90	9.94	839.0	168.0	110.0	20.0	12.0	163.0	15.0	5.00	0.100	38.0	.	1.10
62	DC-13	GRRD	91	9.10	408.0	179.0	13.0	2.0	3.6	87.0	8.0	1.20	0.200	22.0	.	0.10
63	DC-14	GRRD	92	10.10	867.0	208.0	98.0	21.0	13.0	182.0	3.3	0.80	.	54.0	8.68	1.10
64	DC-15	UMTA	93	9.78	860.0	208.0	94.0	20.0	12.0	181.0	3.9	0.70	0.100	56.0	10.16	1.10
65	DC-16	GRRD	94	9.72	852.0	202.0	98.0	20.0	10.0	176.0	5.9	0.60	0.100	49.0	.	1.10
66	DC-17	GRRD	95	9.70	800.0	180.0	90.0	18.1	14.0	166.0	4.7	0.20	0.100	29.0	18.18	0.90
67	DC-18	GRRD	96	9.10	630.0	161.0	68.0	11.0	21.0	134.0	3.0	0.20	.	31.0	31.10	1.30
68	80-62	PRAP	97	9.21	672.8	137.1	103.0	10.3	3.3	142.4	15.2	1.08	0.090	32.6	.	0.05
69	80-80	PRAP	97	9.21	672.8	137.1	104.0	10.1	2.8	145.0	15.1	1.09	0.100	32.6	.	0.04
70	80-100	PRRZ	98	9.40	653.2	139.7	96.5	8.9	.	123.0	13.8	1.31	0.046	34.1	.	-0.01
71	80-63	PRRZ	98	9.40	653.2	139.7	95.6	8.9	.	123.4	16.3	1.38	0.052	37.6	.	-0.01
72	80-73	RZFS	99	9.46	.	143.4	105.0	8.2	1.4	125.9	13.8	1.60	0.098	31.3	.	-0.01
73	80-97	RZFS	99	9.46	.	143.4	103.0	8.2	1.2	122.8	13.7	1.56	0.094	31.2	.	-0.01
74	80-32	FRSR	100	9.52	726.1	173.3	.	.	.	243.8	26.5	3.88	0.180	86.3	.	-0.01
75	80-68	FRSR	100	9.52	726.1	173.3	109.1	9.5	5.9	242.1	26.1	3.78	0.180	86.1	.	-0.01
76	80-23	FRSR	101	9.45	707.0	147.4	89.5	6.0	-0.5	134.9	17.1	1.54	0.120	33.0	.	-0.01
77	80-82	FRSR	101	9.45	707.0	147.4	89.6	6.6	-0.5	135.1	17.4	1.52	0.120	32.4	.	-0.01
78	80-102	FRSR	102	9.38	661.5	139.7	102.3	10.3	.	135.1	16.3	1.16	0.076	35.3	.	0.08

OBS	BA	B	CO	CR	CU	FE	LI	MN	MO	NI	PB	SR	ZN
53	0.028	0.170	-0.010	-0.003	0.033	0.970	.	-0.020	-0.03	.	.	.	0.030
54	0.010	-0.020	-0.010	-0.040	-0.010	0.040	0.010	0.010	-0.02	-0.030	-0.15	0.003	-0.010
55	.	0.060	.	.	.	0.250	.	.	.	.	.	.	.
56	.	0.060	.	.	.	0.100	.	.	.	.	.	.	.
57	.	0.100	.	.	.	1.400	.	.	.	.	.	.	.
58	.	0.450	.	.	.	0.570	.	.	.	.	.	.	.
59	.	0.940	.	.	.	0.030	.	.	.	.	.	.	.
60	.	0.730	.	.	.	.	.	.	.	.	.	.	.
61	.	.	.	.	.	0.200	.	.	.	.	.	.	.
62	.	.	.	.	.	1.000	.	.	.	.	.	.	.
63	.	0.720	.	.	.	0.100	.	.	.	.	.	.	.
64	.	0.650	.	.	.	0.150	.	.	.	.	.	.	.
65	.	0.170	.	.	.	0.650	.	.	.	.	.	.	.
66	.	0.660	.	.	.	1.800	.	.	.	.	.	.	.
67	.	0.380	.	.	.	2.100	.	.	.	.	.	.	.
68	-0.005	0.940	-0.010	-0.003	-0.002	0.070	-0.020	-0.020	0.24	-0.020	-0.10	0.010	-0.010
69	0.014	0.930	-0.010	-0.003	-0.002	0.080	-0.020	-0.020	0.21	-0.020	-0.10	0.010	-0.010
70	-0.005	0.860	-0.010	-0.003	-0.002	-0.002	-0.020	-0.020	-0.03	-0.020	-0.10	0.005	-0.002
71	-0.005	0.940	-0.010	-0.003	-0.002	0.014	-0.020	0.042	0.05	-0.020	-0.10	0.009	-0.002
72	-0.005	0.760	-0.010	-0.003	-0.002	0.014	-0.020	-0.020	-0.03	-0.020	-0.10	0.031	-0.002
73	-0.005	0.760	-0.010	-0.003	-0.002	0.014	-0.020	-0.020	-0.03	-0.020	-0.10	0.030	-0.002
74	-0.005	1.280	-0.010	-0.003	-0.002	0.210	.	-0.020	-0.03	-0.020	-0.10	0.025	-0.002
75	1.090	1.330	-0.010	-0.003	-0.002	0.200	.	-0.020	-0.03	-0.020	-0.10	0.025	-0.002
76	-0.005	0.810	-0.010	-0.003	-0.002	0.045	-0.020	-0.020	-0.03	-0.020	-0.10	0.025	-0.002
77	-0.005	0.800	-0.010	0.005	-0.002	0.180	-0.020	-0.020	-0.03	-0.020	-0.10	0.025	-0.002
78	0.007	0.860	-0.010	-0.003	0.009	0.082	-0 020	-0.020	0.26	-0.020	-0.10	-0.012	-0.002

OBS	SAMPLE	FORM	RECNO	PH	SC	F_ALK	CL	F	SO4	NA	K	CA	MG	SI	TOTC	AL
79	80-124	FRSR	102	9.38	661.5	139.7	103.0	9.8	.	131.0	16.3	1.12	0.070	35.0	.	0.08
80	80-174	GRRD	104	9.57	705.1	144.7	127.6	13.6	1.7	148.2	15.0	1.17	0.051	28.9	.	-0.01
81	80-233	GRRD	106	9.64	.	157.4	117.0	10.7	4.0	138.2	13.0	1.64	0.160	46.3	.	0.04
82	80-243	GRRD	106	9.46	.	157.4	117.0	10.7	4.0	139.4	13.7	1.77	0.170	50.0	.	0.05
83	80-208	GRRD	107	10.18	807.0	210.6	104.4	12.3	15.4	158.6	16.0	5.00	0.051	54.5	.	0.05
84	80-234	GRRD	107	10.18	807.0	210.6	103.1	12.6	13.5	156.9	15.7	5.00	0.051	53.8	.	0.06
85	81-61	GRRD	108	9.52	776.0	150.0	130.7	12.9	4.2	161.4	7.6	1.07	-0.020	54.9	.	0.01
86	81-72	GRRD	108	9.52	776.0	150.0	130.8	13.0	4.2	162.8	7.6	1.05	0.010	56.0	.	0.03
87	82-47	GRRD	109	9.52	744.0	151.8	127.6	13.7	3.0	166.4	7.5	1.28	-0.100	63.2	.	0.19
88	82-85	GRRD	109	9.52	744.0	151.8	132.0	13.7	3.3	167.1	7.6	1.28	-0.100	63.0	.	0.22
89	80-3	ELEM	112	8.35	.	132.4	5.9	1.1	28.1	58.5	10.0	9.95	1.870	27.7	.	0.05
90	80-34	ELEM	112	8.35	.	132.4	5.7	1.0	28.1	58.3	10.0	9.00	1.780	27.8	.	0.06
91	80-16	RATR	113	8.10	.	109.3	6.7	0.8	24.0	49.8	13.4	6.70	1.470	32.4	.	0.03
92	80-53	RATR	113	8.10	.	109.3	6.5	0.8	23.5	48.8	13.1	6.50	1.440	31.8	.	0.03
93	80-47	SELA	114	7.65	263.6	107.8	4.9	0.6	17.6	30.5	12.0	15.10	2.470	32.4	.	0.06
94	80-85	SELA	114	7.65	263.6	107.8	5.0	0.6	18.1	31.9	13.0	16.00	2.600	33.9	.	0.03
95	80-69	ASOT	115	9.41	353.6	144.6	5.9	1.5	17.6	78.0	13.1	1.45	0.077	25.1	.	-0.01
96	80-83	ASOT	115	9.41	353.6	144.6	7.4	2.9	18.8	79.0	12.8	1.46	0.077	25.0	.	-0.01
97	80-36	ASOT	116	9.22	351.7	149.6	7.0	2.9	14.3	81.8	12.2	0.95	0.081	25.6	.	-0.01
98	80-89	ASOT	116	9.22	351.7	149.6	5.5	2.1	19.3	83.5	13.1	0.96	0.081	26.0	.	-0.01
99	80-2	MABT	117	9.44	396.0	151.8	11.9	1.6	29.1	79.4	12.8	7.00	0.260	26.2	.	0.02
100	80-71	MABT	117	9.44	396.0	151.8	11.8	1.5	29.1	79.6	12.7	7.03	0.260	26.1	.	0.04
101	80-136	PRAP	118	8.84	315.8	134.2	6.2	0.9	21.8	64.0	20.0	2.44	0.250	27.8	.	0.04
102	80-144	PRAP	118	8.84	315.8	134.2	6.3	1.0	21.2	65.6	20.4	2.74	0.290	26.8	.	0.04
103	80-127	PRAP	119	8.80	325.9	140.8	6.2	1.0	24.2	65.5	22.1	3.53	0.300	27.4	.	0.03
104	80-189	PRAP	119	8.80	350.0	140.7	6.3	1.0	24.2	64.5	20.6	3.42	0.290	27.0	31.92	0.02

OBS	BA	B	CO	CR	CU	FE	LI	MN	MO	NI	PB	SR	ZN
79	-0.005	0.840	-0.010	0.006	0.010	0.061	-0.020	-0.020	0.31	-0.020	0.12	0.012	-0.002
80	0.196	0.800	-0.010	-0.003	-0.002	0.175	-0.020	-0.020	-0.03	-0.020	-0.10	0.001	0.007
81	0.008	0.780	-0.010	0.020	-0.002	2.000	.	0.030	0.20	-0.020	-0.10	0.007	0.130
82	-0.005	0.860	-0.010	0.020	0.008	2.150	.	0.030	0.20	-0.020	-0.10	0.008	0.140
83	-0.005	0.790	-0.005	-0.005	-0.005	0.050	.	0.242	0.24	-0.010	-0.10	0.020	-0.005
84	-0.005	0.780	-0.005	-0.005	-0.005	0.040	.	0.220	0.17	-0.010	-0.10	0.015	-0.005
85	-0.005	0.700	-0.010	0.007	-0.002	0.062	-0.100	-0.100	-0.03	-0.020	-0.10	0.004	-0.002
86	-0.005	0.750	-0.010	0.004	-0.002	0.056	-0.100	-0.100	-0.03	-0.020	-0.10	0.004	-0.002
87	0.003	0.860	-0.015	-0.036	-0.006	0.270	0.024	0.006	0.16	-0.026	-0.16	0.003	-0.015
88	0.003	0.860	-0.015	-0.036	-0.006	0.300	0.024	0.006	0.16	-0.026	-0.16	0.003	-0.015
89	0.054	0.120	-0.010	-0.003	-0.002	0.160	-0.020	-0.020	0.17	-0.020	-0.10	0.090	-0.010
90	0.053	0.130	-0.010	-0.003	-0.002	0.170	0.020	-0.020	0.25	-0.020	-0.10	0.085	-0.010
91	0.064	-0.005	-0.010	-0.003	-0.002	0.650	-0.020	-0.020	0.04	-0.020	-0.10	0.049	0.020
92	0.061	-0.005	-0.010	-0.003	-0.002	0.061	-0.020	-0.020	0.07	-0.020	-0.10	0.048	0.020
93	0.058	-0.005	-0.010	-0.003	0.005	0.290	-0.020	0.070	0.18	-0.020	-0.10	0.102	0.040
94	0.059	-0.005	-0.010	-0.003	-0.002	0.310	-0.020	0.068	0.06	-0.020	-0.10	0.107	0.045
95	-0.005	0.070	-0.010	0.011	-0.002	0.040	-0.020	-0.020	-0.03	-0.020	-0.10	0.011	0.006
96	-0.005	0.066	-0.010	-0.003	-0.002	0.042	-0.020	-0.020	-0.03	-0.020	-0.10	0.011	-0.002
97	0.235	0.068	-0.010	0.010	-0.002	0.012	-0.020	-0.002	-0.03	-0.020	-0.10	0.009	-0.002
98	-0.005	0.069	-0.010	0.010	-0.002	0.009	-0.020	-0.020	-0.03	-0.020	-0.10	0.009	-0.002
99	0.028	0.040	-0.010	-0.003	-0.002	0.028	-0.020	-0.020	-0.03	-0.020	-0.10	0.048	-0.002
100	0.031	0.042	-0.010	0.008	-0.002	0.048	-0.020	-0.020	-0.03	-0.020	-0.10	0.049	0.006
101	0.016	0.030	-0.010	-0.003	-0.002	0.050	-0.020	-0.020	-0.03	-0.020	-0.10	0.017	-0.002
102	0.012	0.030	-0.010	-0.003	-0.002	0.070	0.030	-0.020	-0.03	-0.020	-0.10	0.019	0.017
103	0.013	0.025	-0.010	-0.003	-0.002	0.040	-0.020	-0.020	-0.03	-0.020	-0.10	0.017	0.010
104	0.006	0.026	-0.010	-0.003	-0.002	0.019	.	-0.020	-0.03	.	-0.10	.	-0.002

OBS	SAMPLE	FORM	RECNO	PH	SC	F_ALK	CL	F	SO4	NA	K	CA	MG	SI	TOTC	AL
105	80-112	ROZA	120	8.75	323.0	134.2	6.6	0.8	16.6	62.7	21.3	3.19	0.210	30.8	.	0.03
106	80-168	ROZA	120	8.75	323.0	134.2	6.9	0.9	16.6	61.3	20.4	3.15	0.200	29.8	.	-0.01
107	80-157	SQCK	121	9.46	357.5	145.2	7.0	2.2	18.9	72.5	13.1	3.99	0.382	19.8	.	-0.01
108	80-183	SQCK	121	9.46	357.5	145.2	7.0	2.2	18.9	71.9	13.2	4.10	0.400	20.0	.	-0.01
109	80-155	FRSR	122	9.41	361.0	145.8	6.9	2.2	20.5	76.1	11.9	1.17	0.053	42.4	.	-0.01
110	80-185	FRSR	122	9.41	361.0	145.8	6.9	2.2	20.5	79.2	12.7	1.23	0.054	42.1	.	-0.01
111	80-104	FRSR	123	9.57	359.2	148.5	5.6	1.8	26.1	80.1	11.6	2.10	0.100	38.7	.	-0.01
112	80-125	FRSR	123	9.57	359.2	148.5	5.6	1.8	26.1	80.1	11.6	2.10	0.100	38.5	.	-0.01
113	80-115	FRSR	124	9.44	358.5	146.3	5.8	2.3	22.9	73.2	11.3	0.95	0.020	58.8	.	0.10
114	80-129	FRSR	124	9.44	358.9	146.3	5.8	2.3	22.9	74.7	11.8	1.01	0.020	60.4	.	0.12
115	80-156	FRSR	125	9.38	351.4	171.0	5.1	2.2	18.6	79.3	13.6	0.88	0.010	60.9	.	-0.01
116	80-170	FRSR	125	9.38	351.4	171.0	5.8	2.3	23.5	78.2	14.1	0.86	0.020	61.2	.	0.07
117	80-117	FRSR	126	9.65	421.4	187.6	8.4	3.9	31.0	113.8	11.7	0.71	0.020	68.7	.	-0.01
118	80-151	FRSR	126	9.65	421.4	187.6	8.4	3.9	31.0	116.1	11.5	0.72	0.020	68.8	.	-0.01
119	80-213	GRRD	127	9.69	757.4	206.6	60.9	24.3	19.8	148.5	9.6	1.25	0.050	72.5	.	0.21
120	80-236	GRRD	127	9.69	757.4	206.6	70.6	24.4	18.7	150.8	9.6	1.32	0.050	75.6	.	0.11
121	81-20	UNKN	128	9.61	1340.0	150.9	222.0	22.0	169.0	263.5	18.0	3.80	0.100	48.4	.	0.10
122	81-22	UNKN	128	9.61	1340.0	150.9	217.0	21.6	166.0	270.0	18.4	3.90	0.100	49.2	.	-0.08
123	81-16	UMTA	129	9.59	1458.0	109.0	231.8	40.7	145.1	315.7	8.3	4.25	0.040	57.3	.	0.11
124	81-30	UMTA	129	9.59	1458.0	109.0	231.4	40.6	144.8	315.6	8.1	4.14	0.040	56.0	.	0.11
125	81-141	UMTB	131	9.74	1532.0	106.4	258.0	50.1	112.8	343.5	7.3	1.82	-0.087	54.2	.	-0.06
126	81-21	GRRD	132	9.39	724.0	168.0	66.4	15.0	58.0	149.6	8.2	1.70	0.030	39.8	.	-0.01
127	81-29	GRRD	132	9.39	724.0	168.0	65.4	15.7	57.2	144.5	8.0	1.60	0.030	39.7	.	-0.01
128	83-411	GRRD	166	9.65	1547.0	114.0	256.1	49.5	150.6	338.9	5.7	1.36	-0.100	52.3	12.46	-0.08
129	83-464	GRRD	166	9.65	1537.0	113.0	256.7	49.7	150.6	337.1	5.7	1.36	-0.100	52.4	.	-0.08
130	80-31	LEVY	167	7.80	364.1	167.5	11.2	1.2	-0.5	60.3	12.6	10.50	3.800	23.1	.	-0.01

OBS	BA	B	CO	CR	CU	FE	LI	MN	MO	NI	PB	SR	ZN
105	0.011	0.030	-0.010	0.006	0.007	0.024	0.020	-0.020	-0.03	-0.020	-0.100	0.012	-0.002
106	-0.005	-0.010	-0.010	-0.003	-0.002	-0.005	-0.030	-0.020	-0.03	-0.020	-0.100	0.008	-0.002
107	-0.005	0.036	-0.010	-0.003	-0.002	0.065	-0.020	-0.020	-0.03	-0.020	-0.100	0.064	-0.002
108	-0.005	0.036	-0.010	-0.003	-0.002	0.186	-0.020	-0.020	-0.03	-0.020	-0.100	0.066	-0.002
109	-0.005	0.053	-0.010	-0.010	-0.002	-0.010	-0.020	-0.020	-0.03	-0.020	-0.100	0.010	-0.007
110	-0.005	0.032	-0.010	-0.003	-0.002	-0.005	-0.020	-0.020	-0.03	-0.020	-0.100	0.008	-0.002
111	-0.005	0.030	-0.010	-0.003	-0.002	0.015	.	-0.020	-0.03	-0.020	-0.100	0.010	-0.002
112	-0.005	9.034	-0.010	-0.003	-0.002	0.043	-0.020	-0.020	-0.03	-0.020	-0.100	0.013	-0.002
113	-0.005	0.060	-0.010	-0.003	-0.002	0.030	.	0.030	0.22	-0.020	0.180	-0.001	-0.002
114	-0.005	0.070	-0.010	0.010	-0.002	0.010	.	0.020	0.27	-0.020	0.180	-0.001	-0.002
115	-0.005	0.030	-0.010	-0.003	-0.002	-0.010	.	-0.020	-0.03	-0.020	-0.100	-0.001	-0.002
116	-0.005	0.060	-0.010	0.010	-0.007	0.010	.	0.050	0.19	-0.020	0.230	-0.001	0.020
117	-0.005	-0.010	-0.010	-0.003	-0.002	0.074	.	-0.020	-0.03	-0.020	-0.100	0.005	-0.002
118	-0.005	-0.010	-0.010	0.007	-0.002	0.080	.	-0.020	-0.03	-0.020	-0.100	0.005	-0.002
119	0.023	0.580	0.020	0.030	0.030	0.100	.	-0.020	0.94	0.050	0.370	0.014	0.010
120	-0.005	0.590	-0.010	0.010	-0.002	0.080	.	-0.020	0.26	0.020	0.170	0.012	-0.002
121	0.020	0.500	-0.005	-0.005	0.007	0.100	.	0.300	0.80	-0.010	-0.100	0.040	0.005
122	0.020	0.500	-0.005	-0.005	-0.005	0.100	.	0.300	0.75	-0.010	-0.100	0.050	-0.005
123	0.020	0.990	-0.010	-0.010	-0.005	0.030	.	0.280	0.87	-0.010	0.100	0.030	0.010
124	0.020	0.980	-0.010	0.010	-0.005	0.010	.	0.320	0.91	-0.010	-0.100	0.030	0.007
125	0.003	1.390	-0.030	-0.040	-0.005	0.030	0.010	-0.003	0.61	-0.030	-0.120	0.005	0.029
126	0.008	0.450	-0.010	-0.003	0.002	0.010	-0.020	-0.100	0.15	-0.020	0.100	0.020	-0.020
127	0.009	0.440	0.010	-0.003	-0.002	0.010	-0.020	-0.100	0.19	-0.020	0.100	0.020	-0.002
128	0.004	1.090	-0.010	-0.040	-0.010	-0.010	0.030	-0.004	0.62	-0.030	-0.150	0.010	-0.010
129	0.004	1.090	-0.010	-0.040	-0.010	-0.010	0.030	-0.004	0.63	-0.030	-0.150	0.010	-0.010
130	0.061	0.050	-0.010	-0.003	-0.002	0.110	-0.020	0.050	-0.03	-0.020	-0.100	0.064	0.110

OBS	SAMPLE	FORM	RECNO	PH	SC	F_ALK	CL	F	SO4	NA	K	CA	MG	SI	TOTC	AL
131	80-56	LEVY	167	7.80	364.1	167.5	11.3	1.2	-0.5	61.3	12.4	10.70	3.840	25.5	.	-0.01
132	80-54	RATR	168	8.25	301.9	157.9	8.4	1.0	-0.5	58.2	12.6	8.97	2.450	25.5	.	-0.02
133	80-76	RATR	168	8.25	301.9	157.9	7.8	1.0	-0.5	59.0	12.6	9.17	2.500	26.0	.	-0.02
134	80-57	COCK	169	8.06	179.5	248.6	15.5	1.1	-0.5	112.3	12.1	3.08	0.510	32.8	.	-0.01
135	80-65	COCK	169	8.06	179.5	248.6	9.8	0.7	-0.5	122.7	12.9	3.44	0.550	33.7	.	-0.01
136	80-87	MABT	170	8.27	477.0	232.6	17.9	2.0	.	108.5	13.6	2.58	0.950	28.5	.	-0.01
137	80-94	MABT	170	8.27	477.0	232.6	17.8	2.0	.	109.6	13.8	2.59	0.950	28.6	.	-0.01
138	80-137	PRRZ	171	9.42	419.5	130.1	46.0	11.5	2.0	89.1	11.1	1.08	0.032	32.6	.	0.04
139	80-197	PRRZ	171	9.42	419.5	130.1	46.9	11.4	2.4	91.3	11.0	1.07	0.032	32.8	.	0.03
140	80-130	ROZA	172	9.31	450.0	138.6	35.9	9.0	-0.5	97.7	14.2	1.06	0.034	32.5	.	0.03
141	80-176	ROZA	172	9.31	450.0	138.6	38.6	9.5	-0.5	97.5	14.2	1.04	0.034	32.1	.	-0.01
142	80-135	FRSR	173	9.43	.	148.4	40.1	9.1	2.7	98.1	14.5	1.54	0.038	37.8	.	0.07
143	80-149	FRSR	173	9.43	.	148.5	39.7	9.3	.	97.8	13.3	1.67	0.040	36.3	.	0.05
144	80-120	FRSR	174	9.36	515.7	162.3	44.5	10.9	1.3	101.7	15.9	1.33	0.055	37.7	.	-0.01
145	80-139	FRSR	174	9.36	515.7	162.3	44.5	10.9	1.3	100.2	15.4	1.33	0.054	37.7	.	-0.01
146	80-108	FRSR	175	9.54	583.6	151.8	66.0	12.1	7.5	111.2	14.0	0.95	0.030	55.7	.	0.10
147	80-131	FRSR	175	9.54	583.6	151.8	64.7	11.8	7.5	117.3	13.6	0.96	0.030	56.1	.	0.07
148	80-114	FRSR	176	9.63	627.6	184.8	70.7	8.6	4.8	122.0	12.8	1.60	0.032	58.0	.	-0.01
149	80-193	FRSR	176	9.63	627.6	184.8	72.2	8.6	4.8	120.0	13.3	1.60	0.033	59.2	.	-0.01
150	81-24	GRRD	177	9.13	1070.0	94.4	170.0	11.5	140.0	199.0	10.6	3.50	0.230	40.8	.	0.07
151	81-41	GRRD	177	9.13	1070.0	94.4	165.0	11.5	141.0	199.7	10.8	3.50	0.220	41.2	.	0.11
152	81-2	GRRD	178	9.34	1148.0	86.2	224.0	18.4	119.0	217.0	14.6	5.90	0.800	43.4	.	0.70
153	81-36	GRRD	178	9.34	1148.0	86.2	224.0	18.3	119.0	217.4	15.0	6.00	0.800	44.5	.	0.70
154	81-46	COHA	179	9.27	1119.0	78.3	183.4	17.5	139.6	229.2	11.9	10.40	0.080	38.3	.	0.15
155	81-50	COHA	179	9.27	1119.0	78.3	182.5	17.4	139.6	229.9	11.7	10.30	0.080	38.0	.	0.15
156	81-32	GRRD	180	9.13	1248.0	52.3	206.2	22.9	198.8	234.7	14.8	7.90	0.030	43.9	.	0.10

OBS	BA	B	CO	CR	CU	FE	LI	MN	MO	NI	PB	SR	ZN
131	0.063	0.050	-0.010	-0.003	-0.002	0.120	-0.020	0.060	-0.03	-0.020	-0.100	0.065	0.110
132	0.068	0.020	-0.010	-0.003	-0.002	0.050	-0.020	-0.020	-0.03	-0.020	-0.100	0.061	0.020
133	0.074	-0.010	-0.010	-0.003	-0.002	0.060	-0.020	-0.020	-0.03	-0.020	-0.100	0.052	0.020
134	0.058	0.045	-0.010	0.007	-0.002	0.320	-0.020	0.030	-0.03	-0.020	-0.100	0.032	0.080
135	0.065	0.038	-0.010	-0.003	-0.002	0.320	-0.020	0.034	-0.03	-0.020	-0.100	0.034	0.070
136	0.033	0.085	-0.010	0.005	-0.002	0.500	0.030	0.038	-0.03	-0.020	-0.100	0.018	0.040
137	0.017	0.086	-0.010	-0.003	-0.002	0.490	0.050	0.039	-0.03	-0.020	-0.100	0.018	0.043
138	-0.005	0.260	-0.012	-0.003	-0.002	0.020	-0.020	-0.020	0.10	-0.020	-0.100	0.003	-0.002
139	-0.005	0.260	-0.010	-0.003	-0.002	0.015	-0.020	-0.020	-0.03	-0.020	-0.100	0.003	-0.002
140	0.009	0.220	-0.010	-0.003	0.008	0.030	-0.020	-0.020	0.14	-0.020	-0.100	0.005	-0.002
141	-0.005	0.210	-0.010	-0.003	-0.002	0.010	-0.020	-0.020	-0.03	-0.020	-0.100	0.002	-0.002
142	0.008	0.220	-0.010	-0.003	0.010	0.097	-0.020	-0.020	0.19	-0.020	-0.100	0.005	-0.002
143	-0.005	0.230	-0.010	-0.003	-0.002	0.110	-0.020	-0.020	-0.03	-0.020	-0.100	0.005	-0.002
144	0.012	0.220	-0.010	-0.003	-0.002	0.062	-0.020	-0.020	-0.03	-0.020	-0.100	0.004	-0.002
145	-0.005	0.210	-0.010	-0.003	-0.002	0.058	-0.020	-0.020	-0.03	-0.020	0.100	0.004	-0.002
146	-0.005	0.290	-0.010	-0.003	-0.002	0.060	.	0.050	0.29	-0.020	-0.100	-0.001	-0.002
147	-0.005	0.290	-0.010	-0.003	-0.002	0.050	.	0.040	0.20	-0.020	0.180	-0.001	-0.002
148	-0.005	0.190	-0.010	-0.003	-0.002	0.040	.	-0.020	-0.03	-0.020	-0.100	-0.001	0.030
149	-0.005	0.210	-0.010	-0.003	-0.002	0.040	.	0.050	-0.03	-0.020	-0.100	0.002	0.030
150	0.010	0.350	-0.005	-0.005	0.008	0.150	.	0.260	0.72	0.010	-0.100	0.030	0.030
151	0.010	0.360	0.007	0.010	0.014	0.160	.	0.270	0.83	0.010	-0.100	0.030	0.029
152	0.030	0.500	-0.005	0.030	0.010	15.030	.	0.300	0.80	-0.010	-0.100	0.030	0.300
153	0.030	0.500	0.006	0.030	0.020	15.400	.	0.300	0.90	-0.010	-0.100	0.030	0.300
154	0.020	0.650	-0.010	0.008	-0.005	0.200	.	0.370	0.83	-0.010	-0.100	0.040	0.008
155	0.020	0.650	-0.010	0.010	-0.005	0.200	.	0.390	0.83	0.010	-0.100	0.040	0.010
156	0.030	0.810	-0.010	0.008	-0.005	0.080	.	0.360	0.98	-0.010	0.610	0.030	0.010

OBS	SAMPLE	FORM	RECNO	PH	SC	F_ALK	CL	F	SO4	NA	K	CA	MG	SI	TOTC
157	81-33	GRRD	180	9.13	1248.0	52.3	205.7	22.8	198.8	251.6	23.6	7.80	0.030	42.5	.
158	81-27	UMTA	181	9.46	1246.0	104.0	189.0	32.6	131.8	259.4	5.8	2.08	0.020	51.6	.
159	81-74	UMTA	181	9.46	1246.0	104.0	190.0	32.8	133.8	262.4	5.6	2.11	-0.025	54.8	.
160	81-64	UMTA	182	9.20	1771.0	75.0	308.1	23.5	214.9	361.6	8.1	4.30	0.090	40.6	.
161	81-69	GRRD	184	9.02	1334.0	86.0	224.8	21.8	175.6	271.2	3.9	2.22	0.027	37.6	.
162	81-84	GRRD	184	9.02	1334.0	86.0	224.8	21.8	175.8	263.2	3.7	2.11	0.028	36.8	.
163	82-41	GRRD	185	9.81	1192.0	146.3	138.2	46.9	105.9	265.3	2.7	1.80	-0.100	54.7	.
164	82-94	GRRD	185	9.81	1192.0	146.3	137.2	46.3	107.2	271.2	2.9	1.80	-0.100	54.0	.
165	81-109	RATR	186	8.32	494.0	224.0	3.6	0.5	22.1	104.0	4.2	10.80	4.900	22.2	.
166	81-167	RATR	186	8.32	494.0	223.5	3.6	0.5	21.9	98.2	3.9	10.10	4.600	22.2	.
167	82-17	SELA	187	7.25	293.0	148.0	3.6	0.5	4.4	46.6	6.4	14.90	3.500	9.9	.
168	82-55	SELA	187	8.04	293.0	140.5	3.6	0.5	4.4	46.8	6.4	15.00	3.500	9.9	.
169	82-45	MABT	188	8.86	340.0	184.0	5.1	0.7	4.6	68.6	11.6	6.00	1.500	33.9	.
170	82-93	MABT	188	8.86	340.0	184.0	4.9	0.6	4.6	68.7	11.6	6.00	1.500	34.2	.
171	82-19	RZFS	189	9.14	795.0	150.0	146.0	9.5	2.0	164.7	17.0	2.00	-0.100	38.3	.
172	82-88	RZFS	189	9.14	795.0	150.0	147.0	9.9	2.0	166.1	16.9	2.00	-0.100	39.4	.
173	82-140	FRSR	190	9.40	878.0	151.0	170.0	9.9	1.2	179.5	18.2	1.67	-0.100	36.1	.
174	82-188	FRSR	190	9.40	878.0	151.0	172.0	10.0	1.2	180.1	18.3	1.67	-0.100	36.1	.
175	82-124	FRSR	191	9.39	697.0	144.0	110.0	13.0	1.9	141.6	20.3	1.70	-0.100	40.8	.
176	82-172	FRSR	191	9.39	697.0	144.0	109.0	13.0	1.9	140.6	20.1	1.70	-0.100	40.6	.
177	82-126	FRSR	192	9.40	1236.0	102.0	308.0	10.9	6.7	231.5	34.4	4.80	-0.100	37.7	.
178	82-143	FRSR	192	9.40	1216.0	102.0	309.0	10.8	6.5	232.2	34.6	4.90	-0.100	38.0	.
179	82-183	FRSR	192	.	.	.	4.3	0.6	.	29.5	8.0	17.00	8.900	29.6	.
180	82-202	FRSR	194	9.10	1230.0	107.6	264.0	12.4	6.1	217.0	30.2	3.90	-0.100	33.7	.
181	82-228	FRSR	194	9.10	1230.0	107.6	265.0	12.4	6.0	227.0	31.5	4.10	-0.100	34.2	.
182	82-322	FRSR	195	9.11	1673.0	90.0	442.0	24.2	2.3	324.0	32.0	3.89	-0.100	37.9	.

OBS	AL	BA	B	CO	CR	CU	FE	LI	MN	MO	NI	PB	SR	ZN
157	0.11	0.020	0.77	-0.010	0.010	-0.005	0.080	.	0.470	0.99	0.010	-0.100	0.030	-0.005
158	0.05	-0.005	0.76	-0.010	-0.003	-0.002	0.043	-0.100	-0.100	-0.03	-0.020	-0.100	0.008	-0.002
159	0.05	0.004	0.91	-0.004	-0.006	-0.003	0.034	0.006	-0.001	-0.03	-0.008	-0.043	0.008	-0.004
160	0.14	0.020	0.81	-0.010	0.009	-0.002	0.500	0.100	0.310	1.22	-0.020	-0.100	0.020	0.003
161	0.06	0.007	0.78	-0.010	-0.003	-0.002	0.055	0.103	-0.100	-0.03	-0.020	-0.100	0.011	0.002
162	0.04	-0.005	0.74	-0.010	0.007	-0.002	0.047	0.110	-0.100	-0.03	-0.020	-0.100	0.010	0.007
163	0.36	0.009	2.34	-0.015	-0.036	-0.006	0.140	0.020	-0.003	0.47	-0.026	-0.150	0.012	-0.015
164	0.36	0.013	2.32	-0.015	-0.036	-0.006	0.160	0.020	0.004	0.47	-0.026	-0.150	0.012	-0.015
165	-0.08	0.030	-0.02	-0.020	0.230	-0.006	0.080	0.007	0.020	-0.02	-0.030	-0.150	0.060	-0.020
166	0.08	0.030	-0.02	-0.020	0.220	-0.006	0.080	0.007	0.020	-0.02	-0.030	-0.150	0.060	-0.020
167	-0.08	0.003	0.02	-0.020	-0.040	-0.006	0.070	0.020	0.030	-0.02	0.030	-0.160	0.040	-0.020
168	-0.08	0.007	-0.02	-0.020	-0.040	-0.006	0.060	0.020	0.030	-0.02	-0.030	-0.160	0.040	-0.020
169	-0.08	0.024	0.05	-0.010	-0.030	-0.006	0.090	0.030	0.040	-0.02	-0.030	-0.150	0.044	-0.010
170	-0.08	0.024	0.05	-0.010	-0.030	-0.006	0.090	0.030	0.040	-0.02	-0.030	-0.150	0.043	-0.010
171	-0.08	0.008	0.50	-0.010	0.080	-0.006	0.100	-0.006	-0.003	0.15	-0.020	-0.150	0.015	-0.010
172	-0.08	0.007	0.51	-0.010	0.080	-0.006	0.110	-0.006	-0.003	0.15	-0.020	-0.150	0.015	-0.010
173	-0.08	0.006	0.60	-0.010	-0.030	-0.006	0.070	-0.006	0.004	0.20	-0.020	-0.150	0.011	-0.010
174	-0.08	0.005	0.60	-0.010	-0.030	-0.006	0.070	-0.006	0.005	0.21	-0.020	-0.150	0.011	-0.010
175	-0.08	0.007	0.63	-0.010	0.050	-0.006	0.050	0.007	0.004	0.10	-0.020	-0.150	0.011	-0.010
176	-0.08	0.007	0.62	-0.010	0.050	-0.006	0.050	0.010	0.004	0.10	-0.020	-0.150	0.011	-0.010
177	-0.08	0.026	0.61	-0.010	0.060	-0.006	0.070	0.020	-0.003	0.13	-0.020	-0.150	0.017	-0.010
178	-0.08	0.026	0.62	-0.010	0.060	-0.006	0.057	0.020	-0.003	0.14	-0.020	-0.150	0.017	-0.010
179	-0.08	0.024	-0.02	-0.010	-0.030	-0.006	0.050	0.014	0.060	-0.02	-0.020	-0.150	0.062	0.190
180	-0.07	0.017	0.54	-0.010	0.100	-0.006	1.810	0.010	0.069	0.04	-0.020	-0.150	0.014	-0.010
181	-0.07	0.017	0.54	-0.010	0.090	-0.006	2.260	0.010	0.080	0.04	-0.020	-0.150	0.015	-0.010
182	-0.08	0.014	1.43	-0.010	-0.030	-0.006	0.030	0.110	-0.003	0.18	-0.020	-0.150	0.019	-0.010

OBS	SAMPLE	FORM	RECNO	PH	SC	F_ALK	CL	F	SO4	NA	K	CA	MG	SI	TOTC
183	82-361	FRSR	195	9.11	1673.0	90.0	438.7	24.0	2.3	320.1	31.6	3.82	-0.100	37.5	.
184	82-332	FRSR	196	9.30	1663.0	126.0	451.8	25.9	2.5	322.6	29.4	4.30	-0.100	34.0	.
185	82-358	FRSR	196	9.30	1663.0	126.0	451.8	26.1	2.6	324.9	29.5	4.30	-0.100	34.4	.
186	82-430	VANT	198	9.46	1738.0	150.0	412.0	27.3	8.4	346.5	20.0	2.70	-0.100	28.6	.
187	82-473	VANT	198	9.46	1738.0	147.0	415.0	27.7	8.4	355.0	20.4	2.80	-0.100	29.2	.
188	83-29	ROCK	199	9.51	1746.0	.	422.0	26.6	5.5	355.0	24.3	2.60	-0.100	45.9	36.19
189	83-147	MABT	200	7.28	288.0	146.7	7.4	0.7	.	56.3	11.4	4.80	1.460	33.4	.
190	83-100	GRRD	201	9.20	.	124.0	367.0	23.9	4.0	300.0	9.1	1.50	-0.100	42.7	.
191	83-215	MCCO	202	8.80	920.0	130.0	188.8	11.2	1.6	180.3	17.3	1.63	-0.100	38.0	.
192	83-259	MCCO	202	8.80	920.0	130.0	188.8	11.2	1.6	180.0	17.3	1.74	-0.100	37.8	54.32
193	80-25	UNKN	205	8.80	.	390.2	75.5	17.7	44.2	287.0	19.9	55.70	11.700	124.2	.
194	80-4	UNKN	205	8.80	.	390.2	74.6	20.8	45.3	262.8	17.1	35.30	7.400	93.6	.
195	79-30	VANT	207	8.80	1700.0	.	366.0	14.0	-0.5	278.2	23.9	13.00	0.110	35.0	.
196	79-32	VANT	207	8.80	1700.0	.	364.0	13.3	-0.5	286.0	23.1	12.60	0.090	33.6	.
197	80-22	UNKN	208	8.80	1150.0	132.0	130.0	30.6	113.0	233.0	13.3	3.70	1.140	22.1	.
198	80-72	UNKN	208	9.00	1150.0	132.0	130.0	31.1	111.0	232.7	13.7	4.50	1.150	22.5	.
199	80-186	GRRD	212	9.62	1326.8	147.0	296.8	22.4	197.4	349.5	15.9	4.51	0.170	63.1	.
200	80-191	GRRD	212	9.62	1326.0	147.0	290.8	22.2	194.0	365.3	16.3	4.32	0.170	59.5	.
201	80-13	GRRD	213	8.55	2100.0	137.0	258.0	21.4	111.0	431.9	22.1	6.50	0.120	54.9	.
202	80-58	GRRD	213	8.55	2100.0	137.0	259.0	21.5	111.0	445.2	22.6	6.30	0.140	53.4	.
203	79-59	GRRD	214	.	.	.	.	.	.	299.8	7.3	2.00	0.170	50.5	.
204	79-97	GRRD	214	8.80	.	.	.	.	.	281.4	7.4	1.90	0.170	48.7	.
205	80-118	GRRD	215	9.71	1539.0	114.4	166.1	42.2	190.6	310.2	6.7	1.66	0.012	50.0	.
206	80-133	GRRD	215	9.71	1539.0	114.4	152.8	36.6	193.9	310.5	6.5	1.49	0.013	46.1	.
207	81-76	GRRD	216	9.40	1666.0	84.0	289.1	35.6	177.2	358.9	3.4	2.63	-0.001	38.5	.
208	81-82	GRRD	216	9.40	1666.0	84.0	289.1	35.6	177.2	359.7	3.4	2.70	-0.001	38.5	.

OBS	AL	BA	B	CO	CR	CU	FE	LI	MN	MO	NI	PB	SR	ZN
183	-0.08	0.014	1.410	-0.010	-0.030	-0.006	0.025	0.110	-0.003	0.16	-0.02	-0.15	0.018	-0.010
184	-0.08	0.020	1.500	-0.010	-0.030	-0.006	9.300	0.025	0.140	0.15	-0.02	-0.15	0.017	-0.010
185	-0.08	0.019	1.500	-0.010	-0.030	-0.006	8.500	0.024	0.130	0.15	-0.02	-0.15	0.017	-0.010
186	0.29	0.013	2.600	-0.010	0.160	-0.006	0.100	-0.006	0.007	0.25	-0.02	-0.15	0.017	-0.010
187	0.28	0.013	2.600	-0.010	0.160	-0.006	0.100	-0.006	0.008	0.25	-0.02	-0.15	0.017	-0.010
188	-0.08	0.010	2.570	-0.010	0.060	-0.010	0.080	0.010	0.010	0.24	-0.03	-0.15	0.020	-0.010
189	-0.08	0.020	0.080	-0.010	-0.040	-0.010	0.430	0.030	0.040	0.03	-0.03	-0.15	0.030	-0.010
190	0.25	0.050	3.900	-0.010	-0.040	-0.010	3.600	0.010	0.090	0.39	-0.03	-0.15	0.000	-0.010
191	-0.08	0.010	0.810	-0.010	-0.040	-0.010	1.070	0.010	0.030	0.19	-0.03	-0.15	0.005	-0.010
192	-0.08	0.020	0.800	-0.010	-0.040	-0.010	1.060	0.010	0.030	0.18	-0.03	-0.15	0.005	-0.010
193	77.10	0.330	1.400	-0.010	0.090	0.060	48.600	-0.020	0.900	0.50	-0.02	1.30	0.217	2.960
194	13.80	0.430	1.100	0.010	0.080	0.110	32.300	-0.020	0.600	0.50	-0.02	0.85	0.119	2.200
195	0.30	0.020	0.500	-0.010	-0.003	0.016	0.400	.	-0.020	-0.03	.	.	.	-0.020
196	0.21	0.020	0.500	-0.010	-0.003	-0.002	0.250	0.100	-0.020	-0.03	-0.02	-0.10	0.210	-0.020
197	0.49	0.280	1.300	0.010	0.090	0.050	46.900	-0.020	2.300	0.50	0.16	0.30	0.010	3.100
198	57.10	0.130	1.600	0.020	0.090	0.040	51.500	-0.020	2.300	0.60	0.15	0.40	0.014	3.400
199	0.06	-0.005	0.860	-0.010	-0.003	-0.002	0.060	.	0.050	0.58	-0.02	-0.10	0.007	0.030
200	-0.01	-0.005	0.770	-0.010	-0.003	-0.002	0.040	.	-0.020	-0.03	-0.02	-0.10	0.003	-0.002
201	0.04	-0.005	1.000	-0.010	-0.003	-0.002	4.100	-0.020	0.200	0.70	-0.02	-0.10	0.016	0.080
202	0.10	-0.005	0.980	-0.010	0.030	-0.002	4.100	-0.020	0.160	0.90	-0.02	-0.10	0.017	0.090
203	0.17	-0.005	1.040	-0.010	0.003	-0.002	0.760	-0.020	0.030	0.40	-0.02	-0.10	0.009	0.040
204	0.16	-0.005	1.000	0.010	0.010	-0.002	0.700	-0.020	0.020	0.40	-0.02	-0.10	0.009	0.030
205	0.07	-0.005	1.210	-0.010	-0.003	0.009	0.200	-0.020	-0.020	0.66	-0.02	0.11	0.008	0.200
206	0.14	0.010	1.130	0.010	0.020	0.025	0.140	-0.020	-0.020	0.90	0.03	0.19	0.009	0.110
207	0.00	0.010	1.310	-0.010	0.007	-0.002	0.002	0.013	-0.001	0.61	-0.02	-0.10	0.006	-0.001
208	0.01	0.004	1.310	-0.010	0.005	-0.002	0.009	0.012	0.001	0.60	-0.02	-0.10	0.007	0.010

OBS	SAMPLE	FORM	RECNO	PH	SC	F_ALK	CL	F	SO4	NA	K	CA	MG	SI	TOTC
209	80-29	GRRD	218	10.44	966.7	151.8	96.3	34.0	79.5	209.1	1.7	0.95	0.006	54.1	.
210	80-37	GRRD	218	10.40	966.7	151.8	96.3	39.0	79.0	218.5	0.3	0.97	0.006	51.9	.
211	80-45	GRRD	220	10.60	1062.0	173.4	76.9	40.4	157.0	241.5	1.9	0.95	-0.005	51.6	.
212	80-75	GRRD	220	10.60	1062.0	173.4	79.0	41.1	157.0	240.8	1.9	0.93	-0.005	50.2	.
213	82- 9	GRRD	227	9.57	1126.0	160.0	137.0	39.0	83.0	258.7	3.3	3.50	-0.100	45.0	.
214	82-33	GRRD	227	9.57	1126.0	160.0	136.0	39.0	83.0	258.0	3.3	3.50	-0.100	45.0	.
215	80-60	SBFL	229	.	233.0	.	1.4	4.0	18.7	23.6	3.5	16.10	7.210	21.6	.
216	80-90	SBFL	229	.	318.0	.	0.8	4.0	18.7	23.8	3.6	16.40	7.360	21.8	.
217	82-52	PRAP	232	7.66	283.0	145.0	4.4	0.6	.	28.3	7.6	15.90	8.400	29.8	.
218	82-7	PRAP	232	7.66	283.0	145.0	4.6	0.7	.	27.7	7.3	15.60	8.300	29.8	.
219	82-11	PRAP	234	7.68	280.0	133.0	4.8	0.7	.	29.9	8.1	16.80	8.800	29.6	.
220	82-64	PRAP	234	7.68	280.0	133.0	4.7	0.7	.	29.7	8.0	16.60	8.700	29.3	.
221	82-263	ROZA	235	7.70	271.0	139.0	4.1	0.6	.	27.4	7.1	16.70	8.700	28.8	.
222	82-283	ROZA	235	7.70	271.0	139.0	0.6	4.1	.	27.0	7.0	16.40	8.600	28.5	.
223	82-325	RZFS	236	8.11	283.0	142.0	4.5	0.6	.	28.3	7.4	16.40	8.900	28.9	.
224	82-397	RZFS	236	8.11	283.0	142.0	4.9	0.6	.	28.6	7.5	16.50	9.000	29.1	.
225	82-424	FRSR	237	7.45	284.0	146.0	5.1	0.7	.	28.1	7.7	17.30	9.500	29.2	.
226	82-474	FRSR	237	7.45	284.0	146.0	4.9	0.6	.	28.1	7.7	17.60	9.600	29.6	.
227	82-436	FRSR	238	7.80	288.0	148.0	4.2	0.7	0.2	28.2	7.8	17.20	9.200	29.2	36.60
228	82-498	FRSR	238	7.80	288.0	148.0	4.3	0.7	0.2	28.3	7.8	17.40	9.300	29.6	0.54
229	83-32	FRSR	239	7.56	281.0	148.0	4.6	0.6	0.1	27.5	7.8	17.70	8.500	29.9	36.60
230	83-83	FRSR	240	8.16	288.0	151.0	5.0	0.6	0.1	28.7	7.8	17.90	9.300	29.9	38.69
231	83-188	FRSR	241	8.00	282.0	150.0	4.9	0.6	.	31.8	9.2	17.80	5.800	31.0	40.50
232	83-373	GRRD	242	9.40	388.0	193.0	6.8	3.7	1.7	85.4	8.1	2.66	0.260	40.9	.
233	83-331	ROCT	243	9.05	380.0	185.0	7.5	3.4	1.6	87.1	8.1	1.06	-0.100	43.5	.
234	83-460	ROCB	244	9.45	395.0	191.0	7.1	3.5	0.3	89.1	8.2	0.82	-0.100	46.9	.

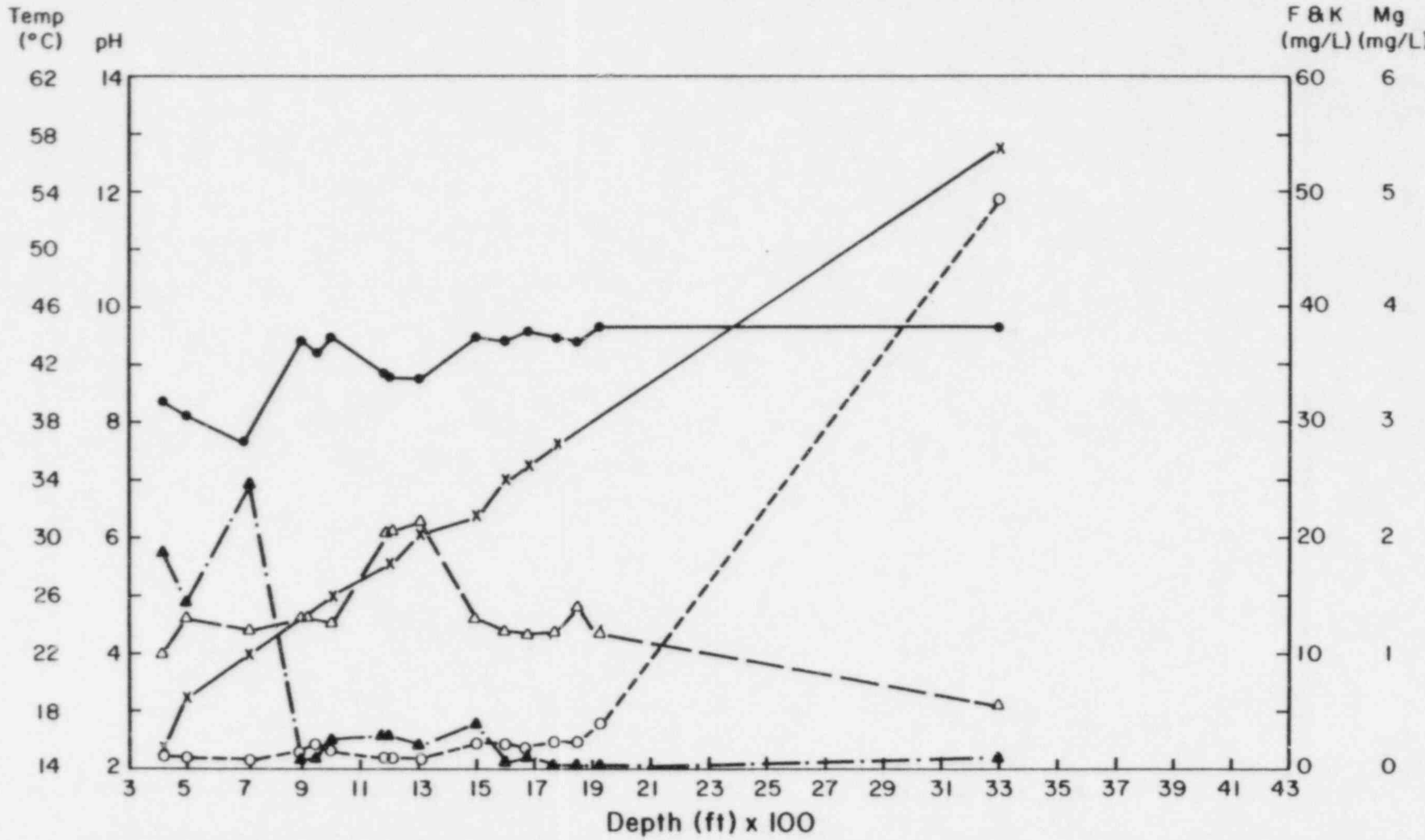
OBS	AL	BA	B	CO	CR	CU	FE	LI	MN	MO	NI	PB	SR	ZN
209	0.11	-0.005	1.520	-0.010	-0.003	0.002	0.004	-0.020	0.040	0.42	-0.02	-0.10	0.004	0.002
210	-0.01	-0.005	1.450	-0.010	-0.003	-0.002	-0.002	-0.020	-0.020	-0.03	-0.02	-0.10	-0.001	-0.002
211	0.05	-0.005	1.200	-0.010	-0.003	-0.002	0.007	.	-0.020	0.16	-0.02	-0.10	0.007	0.010
212	0.05	-0.005	1.170	-0.010	-0.003	-0.002	-0.002	.	-0.020	0.23	-0.02	-0.10	0.007	0.010
213	0.36	0.015	1.870	-0.010	-0.030	-0.006	0.170	-0.006	-0.003	0.47	-0.02	-0.15	0.010	0.050
214	0.38	0.015	1.870	-0.010	-0.030	-0.006	0.190	-0.006	-0.003	0.44	-0.02	-0.15	0.010	0.050
215	0.02	-0.005	-0.005	-0.010	0.024	-0.002	0.063	-0.020	-0.020	-0.03	-0.02	-0.10	0.056	0.006
216	0.03	-0.005	-0.005	-0.010	0.024	-0.002	0.065	-0.020	-0.020	-0.03	-0.02	-0.10	0.057	-0.005
217	-0.08	0.021	-0.020	-0.010	-0.030	-0.006	0.060	0.013	0.060	-0.02	-0.02	-0.15	0.059	-0.010
218	-0.08	0.021	-0.020	-0.010	-0.030	-0.006	0.060	0.014	0.050	-0.02	-0.02	-0.15	0.057	-0.010
219	-0.08	0.022	-0.020	-0.010	-0.030	-0.006	0.050	0.013	0.060	-0.02	-0.02	-0.15	0.062	-0.010
220	-0.08	0.021	-0.020	-0.010	-0.030	-0.006	0.050	0.010	0.060	-0.02	-0.02	-0.15	0.062	-0.010
221	-0.08	0.008	-0.020	-0.010	-0.030	-0.006	0.170	0.010	0.049	-0.01	-0.02	-0.15	0.058	0.040
222	-0.08	0.008	-0.020	-0.010	-0.030	-0.006	0.160	0.010	0.048	-0.01	-0.02	-0.15	0.057	-0.010
223	-0.08	0.011	0.020	-0.010	-0.030	-0.006	0.100	0.020	0.050	-0.02	-0.02	-0.15	0.061	-0.010
224	-0.08	0.011	0.020	-0.010	-0.030	-0.006	0.100	0.017	0.050	-0.02	-0.02	-0.15	0.061	-0.010
225	0.25	0.006	-0.020	-0.010	-0.030	-0.006	0.160	0.009	0.045	-0.02	-0.02	0.17	0.061	-0.010
226	0.26	0.006	-0.020	-0.010	-0.030	-0.006	0.160	0.010	0.046	-0.02	-0.02	-0.15	0.062	-0.010
227	0.25	0.005	-0.020	-0.010	-0.030	-0.006	0.060	0.010	0.040	-0.02	-0.02	0.16	0.060	-0.010
228	0.24	0.005	-0.020	-0.010	-0.030	-0.006	0.060	0.010	0.050	-0.02	-0.02	0.16	0.062	-0.010
229	-0.08	0.010	-0.020	-0.012	-0.040	-0.010	0.490	0.010	0.060	-0.02	-0.03	-0.15	0.060	-0.010
230	-0.08	0.010	-0.020	-0.010	-0.040	-0.010	0.120	0.010	0.050	-0.02	-0.03	-0.15	0.060	-0.010
231	-0.08	0.010	-0.020	-0.010	-0.040	-0.010	0.110	0.020	0.040	-0.02	-0.03	-0.15	0.050	-0.010
232	-0.08	0.010	0.030	-0.010	-0.040	-0.010	0.060	0.010	-0.004	-0.02	-0.03	-0.15	0.020	-0.010
233	-0.08	-0.001	0.060	-0.010	-0.040	-0.010	-0.080	0.020	-0.004	-0.02	-0.03	-0.15	-0.003	-0.010
234	-0.08	0.004	0.060	-0.010	-0.040	-0.010	0.060	0.020	-0.004	-0.02	-0.03	-0.15	0.002	-0.010

OBS	SAMPLE	FORM	RECNO	PH	SC	F_ALK	CL	F	SO4	NA	K	CA	MG	SI	TOTC
235	83-476	CSHT	245	9.40	388.0	181.0	7.6	3.5	0.5	90.9	8.4	0.87	-0.10	45.0	.
236	82-28	?RAP	250	9.14	810.0	173.0	133.0	8.5	1.6	161.5	20.9	2.00	0.20	29.8	.
237	82-68	PRAP	250	9.14	810.0	173.0	133.0	8.5	1.6	161.6	20.9	2.00	0.19	29.8	.
238	8?-65	ROZA	251	9.30	683.0	155.0	122.0	8.6	2.0	141.1	15.5	1.90	-0.10	34.0	.
239	82-75	ROZA	251	9.30	683.0	155.0	123.0	9.4	2.0	139.3	15.4	1.90	-0.10	33.4	.
240	82-163	FRSR	252	8.30	1408.0	93.0	326.0	15.0	21.0	286.4	35.6	9.60	0.23	27.0	.
241	82-170	FRSR	252	8.30	1408.0	93.0	344.0	15.0	21.0	282.2	35.1	9.40	0.23	26.6	.
242	82-122	GRRD	253	8.76	1856.0	86.0	507.0	20.0	1.4	373.8	25.3	2.90	-0.10	34.6	.
243	82-192	GRRD	253	8.77	1856.0	85.0	508.0	21.0	1.5	379.4	25.6	2.90	-0.10	35.3	.
244	82-401	COHB	254	9.71	1616.0	165.0	403.9	20.0	4.2	336.8	13.8	2.22	-0.10	44.7	29.80
245	82-479	COHB	254	9.71	1616.0	165.0	406.5	20.0	4.2	336.8	13.9	2.19	-0.10	44.5	29.80
246	82-364	UMIT	255	9.45	1740.0	136.0	451.0	18.2	1.7	354.9	9.4	1.63	-0.10	47.7	.
247	82-381	UMIT	255	9.45	1740.0	136.0	448.0	18.0	1.7	361.1	9.6	1.72	-0.10	48.8	.
248	82-309	UMIA	256	9.34	.	132.0	384.5	17.3	3.5	335.5	8.5	2.84	0.14	36.1	.
249	82-351	UMIA	256	9.34	.	136.0	383.2	17.2	3.7	328.9	8.4	2.80	0.15	35.4	.
250	82-413	UMIB	257	9.78	1747.0	135.0	454.7	20.1	2.4	358.2	5.8	1.85	-0.10	37.1	.
251	82-456	UMIB	257	9.78	1747.0	135.0	455.3	20.1	2.4	363.5	5.9	1.83	-0.10	37.3	24.43
252	80-61	LEVY	260	8.15	347.8	170.5	13.8	0.7	-0.5	50.3	8.7	22.40	6.05	21.2	.
253	80-7	LEVY	260	8.15	347.8	170.5	13.8	0.7	-0.5	51.3	8.9	22.90	6.17	21.5	.

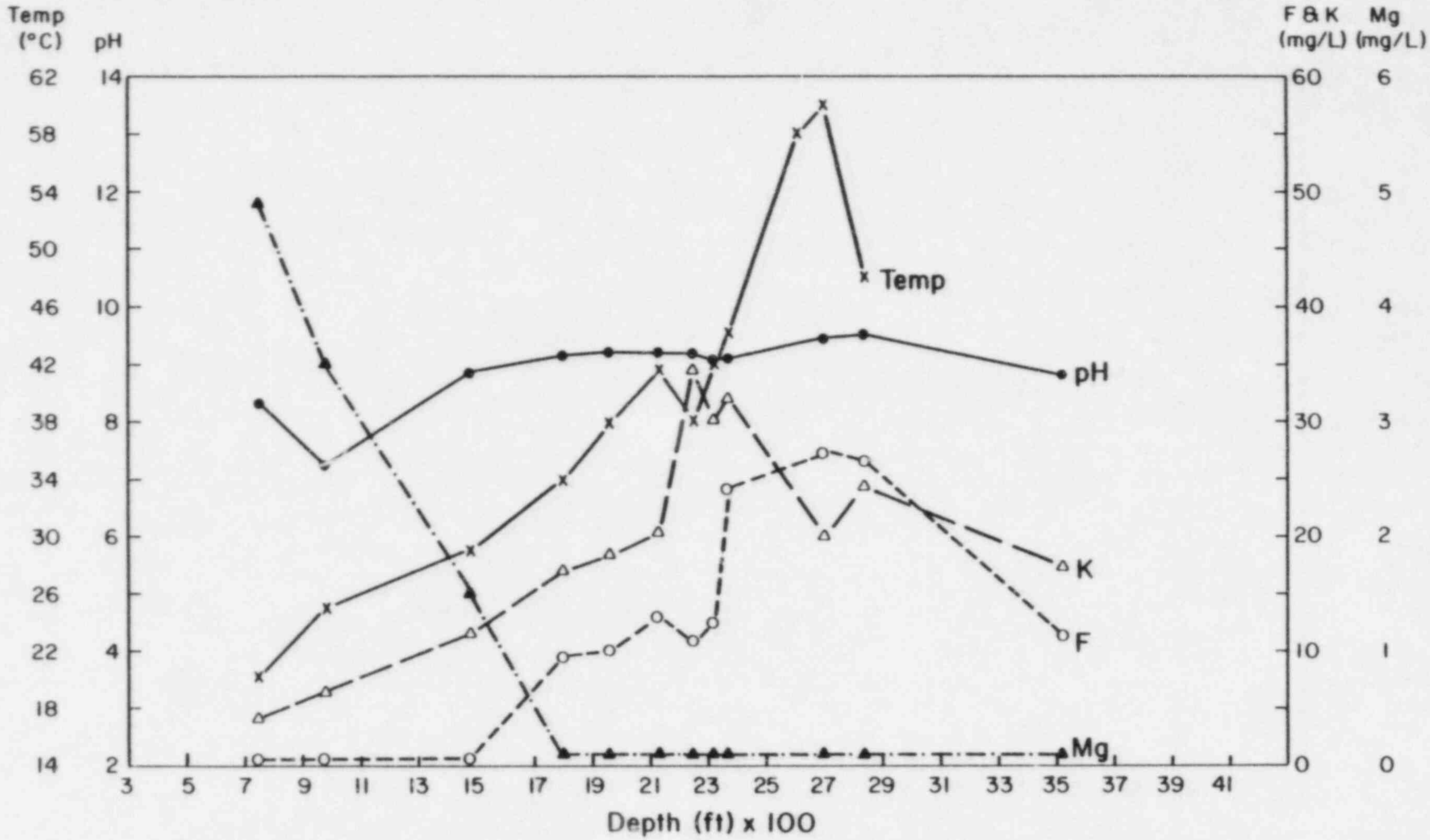
OBS	AL	BA	B	CO	CR	CU	FE	LI	MN	MO	NI	PB	SR	ZN
235	-0.08	0.003	0.040	-0.01	-0.040	-0.010	0.060	0.010	-0.004	-0.02	-0.03	-0.15	-0.003	-0.010
236	-0.08	0.047	0.380	-0.01	0.040	-0.006	6.300	0.010	0.080	0.10	-0.03	-0.15	0.009	0.050
237	-0.08	0.019	0.380	-0.01	0.040	-0.006	6.600	0.010	0.080	0.10	-0.03	-0.15	0.009	0.050
238	-0.08	0.005	0.360	-0.01	-0.030	-0.006	0.390	0.007	0.010	0.12	-0.02	-0.15	0.005	0.020
239	-0.08	0.002	0.350	-0.01	-0.030	-0.006	0.320	0.007	0.009	0.11	-0.02	-0.15	0.005	-0.010
240	-0.08	0.025	1.110	-0.01	-0.030	-0.006	0.100	0.020	0.016	0.05	-0.02	-0.15	0.040	-0.010
241	-0.08	0.024	1.090	-0.01	-0.030	-0.006	0.110	0.017	0.015	0.05	-0.02	-0.15	0.040	-0.010
242	-0.08	0.004	2.600	-0.01	-0.030	-0.006	0.820	0.020	0.032	0.13	-0.02	0.15	0.010	-0.010
243	-0.08	0.003	2.700	-0.01	-0.030	-0.006	0.810	0.020	0.031	0.13	-0.02	0.15	0.010	-0.010
244	0.41	0.002	3.500	-0.01	-0.030	-0.006	0.130	0.030	0.004	0.28	-0.02	-0.15	0.009	-0.010
245	0.41	0.002	3.500	-0.01	-0.030	-0.006	0.130	0.030	0.004	0.27	-0.02	-0.15	0.009	-0.010
246	-0.07	0.004	3.440	-0.01	-0.030	-0.006	0.048	0.040	-0.003	0.27	-0.02	-0.15	0.005	-0.010
247	0.08	0.005	3.520	-0.01	-0.030	-0.006	0.086	0.040	-0.003	0.28	-0.02	-0.15	0.006	0.020
248	0.11	0.003	3.140	-0.01	-0.030	-0.006	0.140	0.030	0.007	0.24	-0.02	-0.15	0.011	0.020
249	0.10	0.007	3.090	-0.01	-0.030	-0.006	0.120	0.030	0.007	0.24	-0.02	-0.15	0.011	0.020
250	0.35	0.002	3.480	-0.01	-0.030	-0.006	0.060	0.040	-0.004	0.26	-0.02	-0.15	0.011	-0.010
251	0.33	0.005	3.510	-0.01	-0.030	-0.006	0.050	0.040	-0.004	0.26	-0.02	-0.15	0.010	-0.010
252	0.05	0.049	0.043	-0.01	0.009	0.002	0.074	-0.020	0.052	-0.03	-0.02	-0.10	0.115	0.010
253	0.03	0.048	0.043	-0.01	0.008	-0.002	0.084	-0.020	0.052	-0.03	-0.02	-0.10	0.118	0.006

APPENDIX C

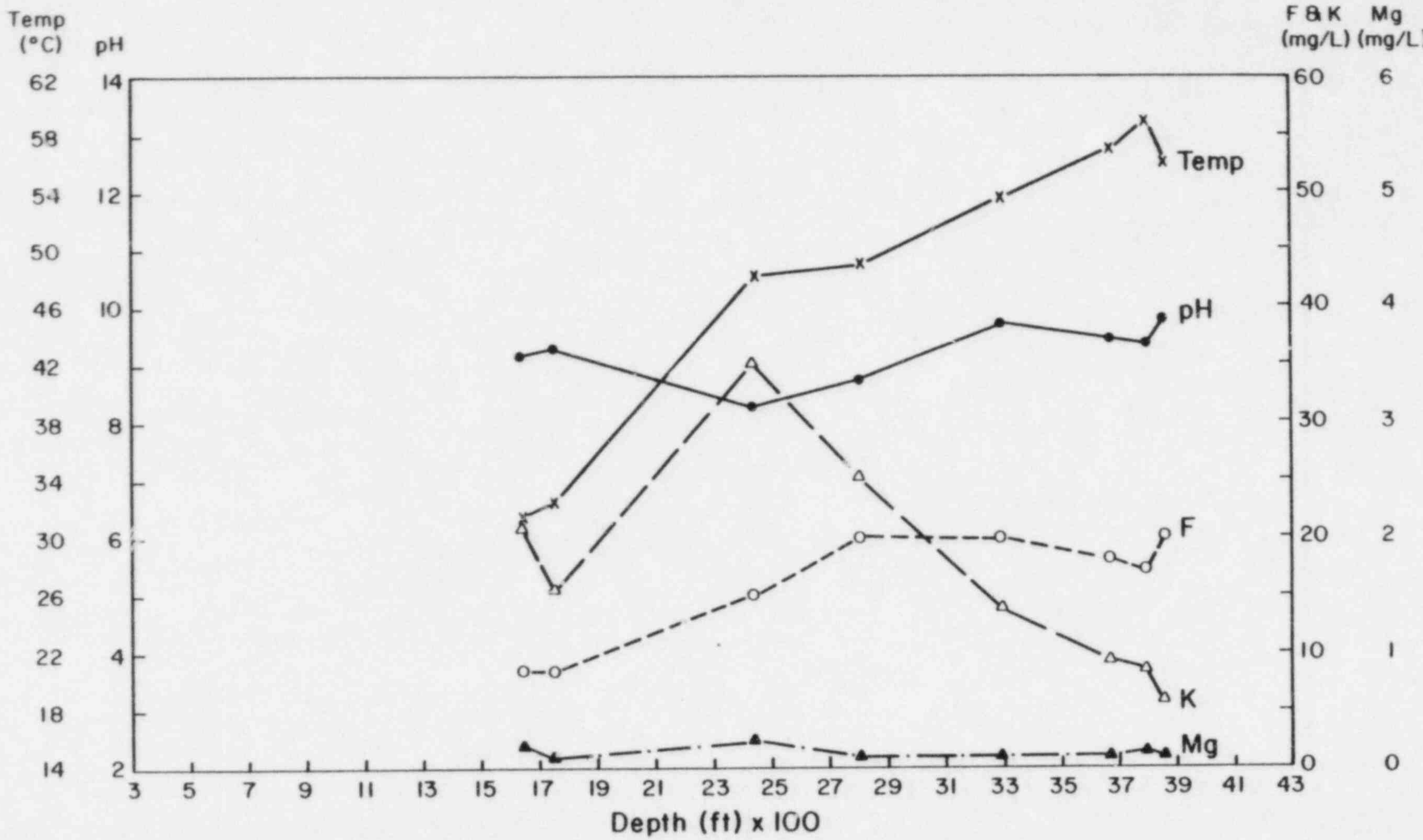
Data Plots of Insitu Temperature and pH and Concentration of Magnesium, Fluoride, and Potassium Versus Depth Below Land Surface



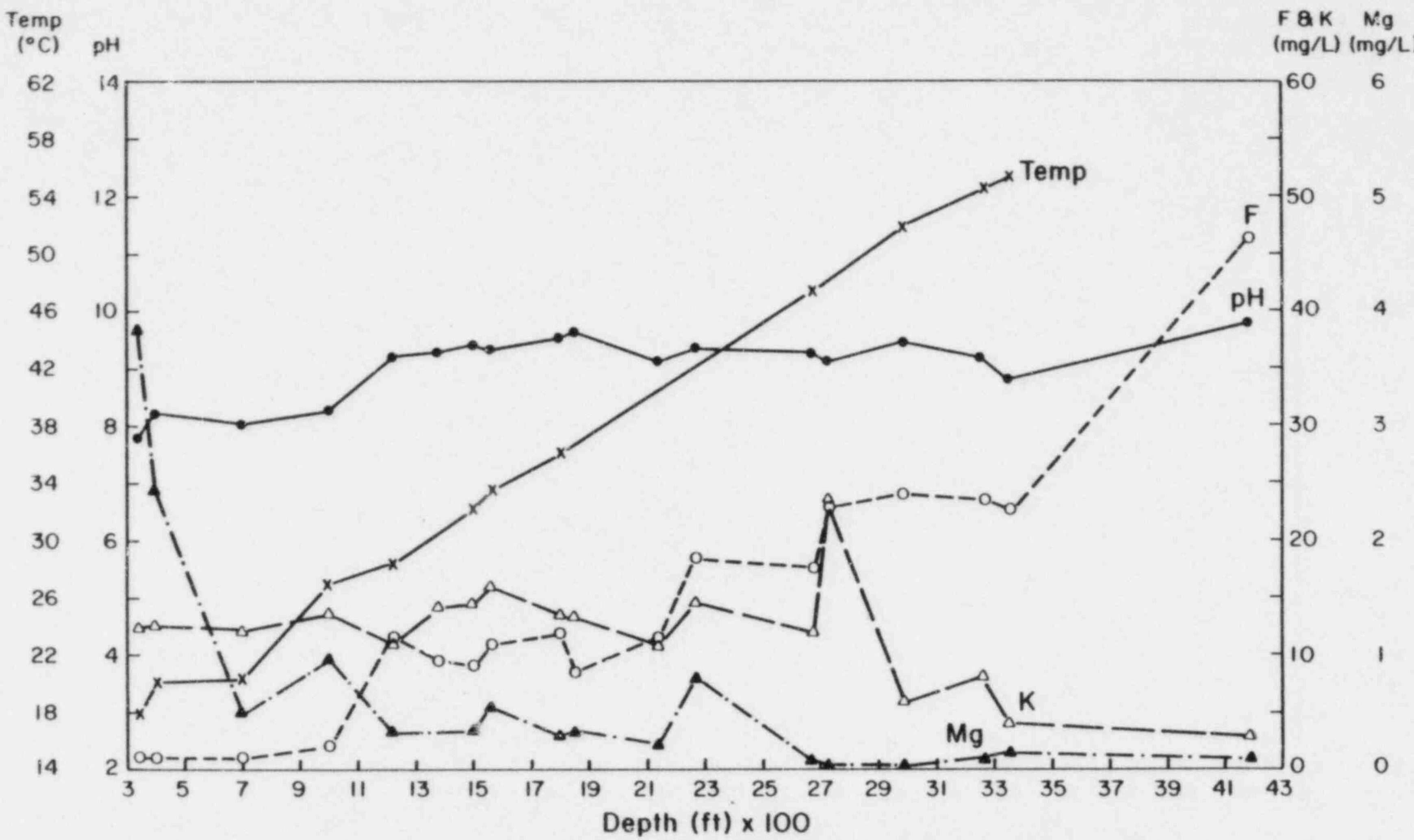
Fluoride, Magnesium and Potassium Concentrations and pH and Insitu Temperature Versus Depth in Borehole DC-14



Fluoride, Magnesium, and Potassium Concentrations and pH and Insitu Termperature Versus Depth in Boreholes DC-16A and C



Fluoride, Magnesium, and Potassium Concentrations and pH and Insitu Temperature Versus Depth in Borehole RRL-2



Fluoride, Magnesium and Potassium Concentrations and pH and Insitu Temperature Versus Depth in Borehole DC-15

APPENDIX D
Summary Statistics for 253 Variables on 26 Variables

(Negative values, designating detection limits, are included as negative values in the following data plots. These small negative values should not affect the summary statistics significantly.)

```
                                                               SAS

                                                           UNIVARIATE

VARIABLE=PH

                MOMENTS                                 QUANTILES(DEF=4)                                 EXTREMES

N                   246  SUM WGTS          246   100% MAX       10.6      99%      10.553        LOWEST    ID        HIGHEST    ID
MEAN            8.98337  SUM           2209.91    75% Q3         9.46      95%        9.78            7(    38)        10.4(   218)
STD DEV        0.720264  VARIANCE      0.51878    50% MED       9.285      90%       9.676            7(    38)       10.44(   218)
SKEWNESS      -0.586235  KURTOSIS    -0.266021    25% Q1       8.3575      10%           8         7.25(   187)        10.5(    89)
USS             19979.5  CSS           127.101     0% MIN           7       5%        7.66         7.25(    27)        10.6(   220)
CV              8.01774  STD MEAN    0.0459223                              1%      7.1175         7.28(   200)        10.6(   220)
T:MEAN=0        195.621  PROB>|T|       0.0001   RANGE            3.6
SGN RANK        15190.5  PROB>|S|       0.0001   Q3-Q1         1.1025
NUM ¬= 0            246                          MODE             8.8
D:NORMAL       0.169886  PROB>D          <0.01

                                                   MISSING VALUE        .
                                                           COUNT        7
                                                    % COUNT/NOBS     2.77

                BAR CHART                     #      BOXPLOT                         NORMAL PROBABILITY PLOT
        10.7+*                                 2        |            10.7+                                               + +
            .**                                3        |                |                                            ++** *
            .                                           |                |                                         +++ *
            .**                                3        |                |                                       ++  **
            .**                                3        |                |                                    +++  **
            .**************                   28        |                |                                 +********
            .*****************************    58     +------+            |                            *******
            .*****************                34     *------*            |                       *****++
            .*********                        18     |      |            |                     *** +++
         8.9+*******                          14     |  +   |         8.9+                     *+++
            .******                           11     |      |            |                   **+
            .*****                             9     |      |            |                ++**
            .***********                      21     +------+            |              +***
            .**********                       19        |                |           ****
            .***                               6        |                |        +++
            .****                              8        |                |     +******
            .**                                4        |                |   +***
            .**                                3        |                | ***
         7.1+*                                 2        |             7.1+*
             ----+----+----+----+----+----                               +----+----+----+----+----+----+----+----+----+----+
             * MAY REPRESENT UP TO 2 COUNTS                                  -2        -1        +0        +1        +2
```

SAS

UNIVARIATE

```
VARIABLE=SC

              MOMENTS                                   QUANTILES(DEF=4)                                  EXTREMES

N                235   SUM WGTS          235    100% MAX      2100     99%    2012.16       LOWEST      ID        HIGHEST      ID
MEAN         737.397   SUM            173288     75% Q3       1062     95%       1738        179.5(    169)        1771(    182)
STD DEV      471.593   VARIANCE       222400     50% MED       630     90%     1542.2        179.5(    169)        1856(    253)
SKEWNESS    0.989971   KURTOSIS -0.0914341     25% Q1      351.4     10%        288          233(    229)        1856(    253)
USS        179823924   CSS          52041648      0% MIN     179.5      5%        280          262(     22)        2100(    213)
CV           63.9538   STD MEAN      30.7634                           1%     198.76        263.6(    114)        2100(    213)
T:MEAN=0       23.97   PROB>|T|       0.0001    RANGE       1920.5
SGN RANK       13865   PROB>|S|       0.0001    Q3-Q1        710.6
NUM ^= 0         235                            MODE           283
D:NORMAL    0.163714   PROB>D          <0.01

                                                   MISSING VALUE       .
                                                           COUNT      18
                                                    % COUNT/NOBS    7.11
```

```
              BAR CHART                                 #     BOXPLOT                           NORMAL PROBABILITY PLOT
        2150+*                                   2        |           2150+                                                  *
            .                                             |               |
        1950+                                             |           1950+                                                  +
            .*                                   2        |               |                                               **
        1750+*****                              10        |           1750+                                         ******+
            .****                                8        |               |                                      ***   ++
        1550+***                                 5        |           1550+                                     **   ++
            .**                                  4        |               |                                    **  ++
        1350+***                                 6        |           1350+                                   **+++
            .****                                8        |               |                                  *++
        1150+*****                              10        |           1150+                                **+
            .**                                  4     +-----+            |                               ++
         950+***                                 5     |     |         950+                             ++**
            .*******                            14     |     |            |                           ++ **
         750+****************                   31     |  +  |         750+                         +****
            .******                             11     *-----*            |                       ++**
         550+****                                7     |     |         550+                    +++ **
            .***********                        22     |     |            |                  ++  ***
         350+******************************     59     +-----+         350+             ***********
            .*************                      25        |               |  *************++
         150+*                                   2        |            150+* +++++++++++++
             ----+----+----+----+----+----+                               +----+----+----+----+----+----+----+----+----+----+
             * MAY REPRESENT UP TO 2 COUNTS                                   -2        -1        +0        +1        +2
```

SAS

UNIVARIATE

VARIABLE=F_ALK

MOMENTS

N	245	SUM WGTS	245
MEAN	150.569	SUM	36889.3
STD DEV	38.8628	VARIANCE	1510.32
SKEWNESS	1.84	KURTOSIS	11.0114
USS	5922887	CSS	368518
CV	25.8107	STD MEAN	2.48286
T:MEAN=0	60.6433	PROB>|T|	0.0001
SGN RANK	15067.5	PROB>|S|	0.0001
NUM ¬= 0	245		
D:NORMAL	0.116398	PROB>D	<0.01

QUANTILES(DEF=4)

100% MAX	390.2	99%	325.061
75% Q3	167.75	95%	208
50% MED	148.4	90%	189.02
25% Q1	134.2	10%	105.44
0% MIN	52.3	5%	86.2
		1%	62.742
RANGE	337.9		
Q3-Q1	33.55		
MODE	134.2		

EXTREMES

LOWEST	ID	HIGHEST	ID
52.3(	180)	232.6(	170)
52.3(	180)	248.6(	169)
75(	182)	248.6(	169)
78.3(	179)	390.2(	205)
78.3(	179)	390.2(	205)

MISSING VALUE	.
COUNT	8
% COUNT/NOBS	3.16

```
      BAR CHART                                                  # BOXPLOT
  390+*                                                          2     *
     .
     .
     .
     .
     .
     .*                                                          2     0
     .**                                                         4     0
     .*****                                                     10     |
     .***********                                               21     |
     .******************                                        35  +-----+
     .***********************************************           93  *--+--*
     .*********************                                     41  +-----+
     .*********                                                 17     |
     .********                                                  15     |
     .**                                                         3     0
   50+*                                                          2     0
      ----+----+----+----+----+----+----+----+----+--
      * MAY REPRESENT UP TO 2 COUNTS
```

```
                        NORMAL PROBABILITY PLOT
  390+                                                          *
     |
     |
     |
     |
     |
     |
     |                                                    ** +
     |                                                +***++
     |                                           ++****
     |                                      ++*****
     |                                  ++******
     |                            *********
     |                      ******++
     |                  ****+++
     |             ******+
     |    ***++
   50+*
      +----+----+----+----+----+----+----+----+----+----+
           -2        -1        +0        +1        +2
```

SAS

UNIVARIATE

VARIABLE=CL

MOMENTS			
N	248	SUM WGTS	248
MEAN	106.296	SUM	26361.4
STD DEV	126.003	VARIANCE	15876.8
SKEWNESS	1.43553	KURTOSIS	1.29692
USS	6723679	CSS	3921568
CV	118.54	STD MEAN	8.00121
T:MEAN=0	13.285	PROB>|T|	0.0001
SGN RANK	15438	PROB>|S|	0.0001
NUM ¬= 0	248		
D:NORMAL	0.200781	PROB>D	<0.01

QUANTILES(DEF=4)			
100% MAX	508	99%	481.666
75% Q3	137.15	95%	413.65
50% MED	69.3	90%	308.01
25% Q1	6.825	10%	4.6
0% MIN	0.6	5%	3.7
		1%	1.094
RANGE	507.4		
Q3-Q1	130.325		
MODE	4.6		

EXTREMES			
LOWEST	ID	HIGHEST	ID
0.6(	235)	451.8(	196)
0.8(	229)	454.7(	257)
1.4(	229)	455.3(	257)
3.3(	30)	507(	253)
3.4(	39)	508(	253)

MISSING VALUE .
COUNT 5
% COUNT/NOBS 1.98

```
     BAR CHART                             #      BOXPLOT              NORMAL PROBABILITY PLOT
 510+*                                     2         0       510+                                                *
    .                                                            |
    .                                                            |
    .***                                   7         0           |                                        ******
    .*                                     2         0           |                                       **      +
 410+**                                    4         0       410+                                      **
    .*                                     2         0           |                                     *      ++
    .*                                     3         0           |                                    **     +
    .*                                     1         0           |                                    *    ++
    .*                                     1         |           |                                    *  ++
 310+*                                     3         |       310+                                   *  +
    .**                                    4         |           |                                  **++
    .*                                     2         |           |                                  *+
    .**                                    5         |           |                                 *+
    .***                                   7         |           |                               **
 210+*                                     3         |       210+                               ++
    .**                                    6         |           |                             ++**
    .**                                    5         |           |                            + **
    .*                                     3         |           |                          ++  *
    .*******                              19      +-----+        |                         +  ***
 110+*********                            26      |  +  |    110+                        ++****
    .****                                 12      |     |        |                      ++ **
    .*****                                13      *-----*        |                     + ***
    .****                                 10      |     |        |                   ++  *
    .**                                    6      |     |        |                  +   *
  10+**********************************  102      +-----+     10+* *********************
     ----+----+----+----+----+----+----                          +----+----+----+----+----+----+----+----+----+----+
     * MAY REPRESENT UP TO 3 COUNTS                                    -2        -1        +0        +1        +2
```

SAS

UNIVARIATE

VARIABLE=F

MOMENTS			
N	248	SUM WGTS	248
MEAN	11.5161	SUM	2856
STD DEV	11.71	VARIANCE	137.123
SKEWNESS	1.2142	KURTOSIS	1.11212
USS	66759.5	CSS	33869.4
CV	101.683	STD MEAN	0.743583
T:MEAN=0	15.4874	PROB>|T|	0.0001
SGN RANK	15301	PROB>|S|	0.0001
NUM ¬= 0	247		
D:NORMAL	0.156471	PROB>D	<0.01

QUANTILES(DEF=4)			
100% MAX	50.1	99%	49.602
75% Q3	18.85	95%	39
50% MED	9.35	90%	26.15
25% Q1	1.1	10%	0.6
0% MIN	-0.3	5%	0.4
		1%	-0.153
RANGE	50.4		
Q3-Q1	17.75		
MODE	0.6		

EXTREMES			
LOWEST	ID	HIGHEST	ID
-0.3(	38)	46.3(	185)
-0.3(	38)	46.9(	185)
0(	12)	49.5(	166)
0.1(	36)	49.7(	166)
0.1(	27)	50.1(	131)

MISSING VALUE .
COUNT 5
% COUNT/NOBS 1.98

```
    BAR CHART                                            #   BOXPLOT        NORMAL PROBABILITY PLOT
 51+*                                                    1     0        51+                                                 *
   .*                                                    2     0          |                                               * *
   .*                                                    2     0          |                                             **
   .                                                                      |
   .*                                                    1     |          |                                           *
   .**                                                   4     |          |                                         **    +
   .**                                                   3     |          |                                        **   +
   .*                                                    1     |          |                                        *  ++
   .**                                                   3     |          |                                       ** +
   .*                                                    2     |          |                                      ** ++
   .*                                                    2     |          |                                      * ++
   .                                                           |          |                                       +
   .**                                                   4     |          |                                     *+
 25+***                                                  5     |        25+                                   +**
   .****                                                 7     |          |                                 +***
   .*********                                           17     |          |                                ***
   .********                                            15  +-----+       |                              ***
   .*****                                               10  |     |       |                            +**
   .***                                                  5  |     |       |                          +**
   .*******                                             13  |     |       |                        ++**
   .*********                                           18  |  +  |       |                      ++***
   .***********                                         21  *-----*       |                    ++***
   .***                                                  5  |     |       |                  + **
   .****                                                 7  |     |       |                ++ *
   .**************                                      28  |     |       |              ++ ****
   .***********************************                 69  +-----+       |  *****************
 -1+**                                                   3     |       -1+* ++++++++++++++
    ----+----+----+----+----+----+----+                                   +----+----+----+----+----+----+----+----+----+----+
    * MAY REPRESENT UP TO 2 COUNTS                                             -2        -1        +0        +1        +2
```

SAS

UNIVARIATE

VARIABLE=SO4

MOMENTS			
N	225	SUM WGTS	225
MEAN	33.3418	SUM	7501.9
STD DEV	53.689	VARIANCE	2882.51
SKEWNESS	1.92421	KURTOSIS	2.44321
USS	895809	CSS	645683
CV	161.026	STD MEAN	3.57927
T:MEAN=0	9.31525	PROB>|T|	0.0001
SGN RANK	12168.5	PROB>|S|	0.0001
NUM ¬= 0	225		
D:NORMAL	0.309822	PROB>D	<0.01

QUANTILES(DEF=4)			
100% MAX	214.9	99%	198.8
75% Q3	27.1	95%	173.62
50% MED	10	90%	139.6
25% Q1	1.9	10%	-0.5
0% MIN	-1.2	5%	-0.5
		1%	-1.2
RANGE	216.1		
Q3-Q1	25.2		
MODE	-0.5		

EXTREMES			
LOWEST	ID	HIGHEST	ID
-1.2(	41)	194(	212)
-1.2(	39)	197.4(	212)
-1.2(	40)	198.8(	180)
-1.2(	40)	198.8(	180)
-1.2(	39)	214.9(	182)

MISSING VALUE .
COUNT 28
% COUNT/NOBS 11.07

```
    BAR CHART                                        #    BOXPLOT
215+*                                                1       *
   .
   .***                                              6       *
   .
   .**                                               4       *
   .*                                                2       *
   .**                                               4       *
   .***                                              6       *
   .*                                                2       *
   .
   .****                                             7       *
105+*                                                2       *
   .
   .*                                                2       0
   .*                                                2       0
   .
   .*                                                2       |
   .**                                               4       |
   .****                                             8       +
   .*************                                   25    +-----+
   .*******************                             37    *-----*
   .**************************************          77    +-----+
 -5+*****************                               34       |
    ----+----+----+----+----+----+----+----
    * MAY REPRESENT UP TO 2 COUNTS
```

```
                     NORMAL PROBABILITY PLOT
 215+                                                   *
    |
    |                                            *** **
    |
    |                                          **
    |                                         *       ++
    |                                       ***      +
    |                                      **    ++
    |                                     **    +
    |                                          ++
    |                                    **  ++
 105+                                   ** ++
    |                                    ++
    |                                  ++
    |                                ++  *
    |                              ++
    |                             +     *
    |                           ++      *
    |                         ++      ***
    |                       ++    ****
    |                     ++  *****
    |            *************
  -5+*************++++++
     +----+----+----+----+----+----+----+----+----+----+
         -2        -1        +0        +1        +2
```

SAS

UNIVARIATE

VARIABLE=NA

```
            MOMENTS                                        QUANTILES(DEF=4)                              EXTREMES

N                252   SUM WGTS        252     100% MAX     445.2      99%    404.074       LOWEST    ID       HIGHEST    ID
MEAN         151.656   SUM         38217.4      75% Q3    224.875      95%        355         16.8(    12)       365.3(   212)
STD DEV      101.927   VARIANCE    10389.1      50% MED    124.65      90%     323.58           17(    29)       373.8(   253)
SKEWNESS    0.779924   KURTOSIS  -0.371724      25% Q1     73.575      10%      32.08         17.1(    29)       379.4(   253)
USS          8403570   CSS         2607659       0% MIN      16.8       5%       28.1         18.5(    18)       431.9(   213)
CV           67.2091   STD MEAN    6.42079                              1%     17.053         23.6(   229)       445.2(   213)
T:MEAN=0     23.6196   PROB>|T|     0.0001     RANGE        428.4
SGN RANK       15939   PROB>|S|     0.0001     Q3-Q1        151.3
NUM ^= 0         252                           MODE          28.3
D:NORMAL    0.122635   PROB>D        <0.01

                                                    MISSING VALUE        .
                                                            COUNT        1
                                                    % COUNT/NOBS      0.40
```

```
STEM LEAF                                  #     BOXPLOT
  44 5                                     1        |
  42 2                                     1        |
  40                                                |
  38                                                |
  36 0124549                               7        |
  34 47055589                              8        |
  32 0345967779                           10        |
  30 000166                                6        |
  28 12667                                 5        |
  26 233450118                             9        |
  24 12242899                              8        |
  22 79022335                              8     +-----+
  20 093779                                6     |     |
  18 1000129                               7     |     |
  16 0112223334455666790016679            25     |     |
  14 11225589015799                       14     |  +  |
  12 02333361145557899                    17     *-----*
  10 0001234590124467                     16     |     |
   8 00023455777990011157888888899        29     |     |
   6 00113344445668991233568888999999     32     +-----+
   4 12477900168899                       14        |
   2 4477788888888990001223336            25        |
   0 7779                                  4        |
     ----+----+----+----+----+----+--
     MULTIPLY STEM.LEAF BY 10**+01
```

```
                      NORMAL PROBABILITY PLOT
  450+                                                   *
     |                                                   *
     |                                                   +
     |                                                 +
     |                                            *****
     |                                        ****++
     |                                      *** ++
     |                                    **  ++
     |                                   ** ++
     |                                  **++
     |                                 *++
  230+                                *+
     |                              +**
     |                            ++**
     |                          ++***
     |                        ++***
     |                      ++***
     |                    ++  **
     |                  ++****
     |                *****
     |             ***+
     |    **********++
   10+* **++++++++++
      +----+----+----+----+----+----+----+----+----+----+
          -2        -1        +0        +1        +2
```

```
                                                                   SAS

                                                               UNIVARIATE

VARIABLE=K

                MOMENTS                                         QUANTILES(DEF=4)                                  EXTREMES

N                  252  SUM WGTS          252    100% MAX       35.6       99%      34.835         LOWEST     ID        HIGHEST     ID
MEAN           12.8901  SUM            3248.3     75% Q3      16.225       95%      25.775            0.3(    218)          32(    195)
STD DEV        6.54651  VARIANCE      42.8568     50% MED       12.5       90%       20.54            1.7(    218)        34.4(    192)
SKEWNESS       1.02684  KURTOSIS      1.56405     25% Q1           8       10%        5.83            1.9(    220)        34.6(    192)
USS            52627.9  CSS             10757      0% MIN        0.3        5%       3.465            1.9(    220)        35.1(    252)
CV             50.7872  STD MEAN     0.412391                               1%       1.806            2.7(    185)        35.6(    252)
T:MEAN=0       31.2569  PROB>|T|       0.0001    RANGE          35.3
SGN RANK         15939  PROB>|S|       0.0001    Q3-Q1       8.22499
NUM ^= 0           252                           MODE            7.8
D:NORMAL     0.0769008  PROB>D          <0.01

                                                               MISSING VALUE          .
                                                                       COUNT          1
                                                               % COUNT/NOBS        0.40

   STEM LEAF                                        #     BOXPLOT                        NORMAL PROBABILITY PLOT
     34 4616                                        4        0           35+                                               ** *
     32 0                                           1        0             |                                              *
     30 256                                         3        0             |                                            **
     28 45                                          2        0             |                                           *       +
     26 15                                          2        |             |                                          *   +++
     24 336                                         3        |             |                                         *++++
     22 116169                                      6        |             |                                       **+
     20 00134446993                                11        |             |                                    ****
     18 01233462239                                11        |             |                                 ++**
     16 033333459000113334667                      21     +-----+          |                              ++***
     14 0012255667789000123344456799               28     |     |          |                           +*****
     12 001246667778889000111122333466677788889    39     *--+--*          |                        +****
     10 0000456666788013455666666778999            31     |     |          |                     ****
      8 00001111122344577788912466699              29     +-----+          |                  ****
      6 2444457011112233344556666778888889         34        |             |             ******
      4 276778899                                   9        |             |           **++
      2 79033344567999                             14        |             |    ********+
      0 3799                                        4        |            1+* **++++++
        ----+----+----+----+----+----+----+----                             +----+----+----+----+----+----+----+----+----+----+
                                                                                -2        -1        +0        +1        +2
```

SAS

UNIVARIATE

VARIABLE=CA

MOMENTS			
N	252	SUM WGTS	252
MEAN	5.71234	SUM	1439.51
STD DEV	7.66427	VARIANCE	58.741
SKEWNESS	2.88437	KURTOSIS	11.2588
USS	22967	CSS	14744
CV	134.17	STD MEAN	0.482803
T:MEAN=0	11.8316	PROB>|T|	0.0001
SGN RANK	15939	PROB>|S|	0.0001
NUM ^= 0	252		
D:NORMAL	0.263214	PROB>D	<0.01

QUANTILES(DEF=4)			
100% MAX	55.7	99%	42.423
75% Q3	6.375	95%	19.145
50% MED	2.29	90%	16.57
25% Q1	1.4	10%	0.95
0% MIN	0.2	5%	0.7165
		1%	0.3219
RANGE	55.5		
Q3-Q1	4.975		
MODE	2		

EXTREMES			
LOWEST	ID	HIGHEST	ID
0.2(	95)	32.2(	18)
0.2(	96)	35.3(	205)
0.43(	5)	42(	29)
0.45(	72)	42.9(	29)
0.49(	5)	55.7(	205)

MISSING VALUE .
COUNT 1
% COUNT/NOBS 0.40

```
      BAR CHART                                                    #   BOXPLOT                     NORMAL PROBABILITY PLOT
57.5+*                                                             1     *        57.5+                                                             *
    .                                                                                 |
    .                                                                                 |
    .*                                                             2     *            |                                                        *  *
    .*                                                             1     *            |                                                      *
    .*                                                             1     *            |                                                    *
    .*                                                             1     *            |                                                  *
    .**                                                            6     *            |                                                *****++ +
    .*******                                                      25     0            |                                         *******++
    .****                                                         14     0            |                                   +++****++
    .*******                                                      26   +--+--+        |                            ++++++****
 2.5+*******************************************                 175   *-----*     2.5+* ******************************
     ----+----+----+----+----+----+----+----+----                                  +----+----+----+----+----+----+----+----+----+----+
     * MAY REPRESENT UP TO 4 COUNTS                                                     -2        -1        +0        +1        +2
```

SAS

UNIVARIATE

VARIABLE=MG

MOMENTS

N	250	SUM WGTS	250
MEAN	1.54926	SUM	387.316
STD DEV	3.19705	VARIANCE	10.2211
SKEWNESS	2.36274	KURTOSIS	4.94801
USS	3145.11	CSS	2545.06
CV	206.359	STD MEAN	0.202199
T:MEAN=0	7.66208	PROB>|T|	0.0001
SGN RANK	11556.5	PROB>|S|	0.0001
NUM ^= 0	250		
D:NORMAL	0.358689	PROB>D	<0.01

QUANTILES(DEF=4)

100% MAX	15.93	99%	14.6024
75% Q3	0.8525	95%	9.2225
50% MED	0.12	90%	7.49
25% Q1	0.02	10%	-0.1
0% MIN	-0.1	5%	-0.1
		1%	-0.1
RANGE	16.03		
Q3-Q1	0.8325		
MODE	-0.1		

EXTREMES

LOWEST	ID	HIGHEST	ID
-0.1(	245)	11.88(	14)
-0.1(	72)	12.4(	18)
-0.1(	166)	13.5(	12)
-0.1(	244)	15.75(	29)
-0.1(	166)	15.93(	29)

MISSING VALUE .
COUNT 3
% COUNT/NOBS 1.19

```
       BAR CHART                                      #    BOXPLOT       NORMAL PROBABILITY PLOT
 15.5+*                                               2      *       15.5+                                              *
     .                                                                   |
     .*                                               1      *           |                                            *
     .*                                               1      *           |                                           *
     .*                                               2      *           |                                         **
     .*                                               1      *           |                                        *
     .***                                             7      *           |                                     ****    +
     .***                                             9      *           |                                  ****   +++
  7.5+**                                              5      *        7.5+                                  **   +++
     .*                                               2      *           |                                  * ++++
     .*                                               3      *           |                                 *++
     .*                                               3      *           |                              +++*
     .**                                              4      *           |                           +++  **
     .***                                             8      0           |                        +++   **
     .****                                           11      +           |                     +++   ***
     .************************************          107    *-----*       |                ***************
 -0.5+****************************                   84      |      -0.5+****************++++
      ----+----+----+----+----+----+----+-                               +----+----+----+----+----+----+----+----+----+----+
      * MAY REPRESENT UP TO 3 COUNTS                                          -2        -1        +0        +1        +2
```

SAS

UNIVARIATE

VARIABLE=SI

MOMENTS			
N	252	SUM WGTS	252
MEAN	38.7956	SUM	9776.5
STD DEV	15.0029	VARIANCE	225.088
SKEWNESS	1.59476	KURTOSIS	5.25131
USS	435783	CSS	56497.1
CV	38.6717	STD MEAN	0.945096
T:MEAN=0	41.0494	PROB>|T|	0.0001
SGN RANK	15813	PROB>|S|	0.0001
NUM ^= 0	251		
D:NORMAL	0.130875	PROB>D	<0.01

QUANTILES(DEF=4)			
100% MAX	124.2	99%	94.023
75% Q3	46.075	95%	63.035
50% MED	35.3	90%	56.87
25% Q1	29.2	10%	25.53
0% MIN	0	5%	21.565
		1%	9.9
RANGE	124.2		
Q3-Q1	16.875		
MODE	29.6		

EXTREMES			
LOWEST	ID	HIGHEST	ID
0(	66)	86.1(	100)
9.9(	187)	86.3(	100)
9.9(	187)	93.6(	205)
11(	79)	94.5(	50)
14.9(	12)	124.2(	205)

MISSING VALUE .
COUNT 1
% COUNT/NOBS 0.40

```
        BAR CHART                           #       BOXPLOT
  122.5+*                                   1          *
       .
       .
       .
       .
       .
       .*                                   2          0
       .**                                  3          0
       .
       .*                                   1          0
       .*                                   1          0
       .*                                   2          |
   62.5+***                                 6          |
       .*********                          18          |
       .*********                          17          |
       .**********                         20       +-----+
       .***********                        22       |     |
       .*******************                37       *--+--*
       .**************************         54       |     |
       .***********************            48       +-----+
       .*******                            15          |
       .*                                   1          |
       .**                                  3          |
       .                                               |
    2.5+*                                   1          0
        ----+----+----+----+----+--
        * MAY REPRESENT UP TO 2 COUNTS
```

```
                          NORMAL PROBABILITY PLOT
  122.5+                                                       *
       |
       |
       |
       |
       |
       |                                                     * *
       |                                                  ***
       |
       |                                                 *    +
       |                                                 * +++
       |                                                *++
   62.5+                                            ***
       |                                       +****
       |                                   *****
       |                                +***
       |                            +++***
       |                        ++****
       |                    +*****
       |          ***********
       |     ****** +++
       |    *     +++
       |  ** ++++
       |***+++
    2.5++++
        +----+----+----+----+----+----+----+----+----+----+
            -2        -1        +0        +1        +2
```

```
                                                        SAS

                                                     UNIVARIATE

VARIABLE=TOTC

               MOMENTS                                         QUANTILES(DEF=4)                                      EXTREMES

N                 27   SUM WGTS          27     100% MAX     54.32      99%        54.32        LOWEST      ID      HIGHEST      ID
MEAN         31.2507   SUM           843.77      75% Q3      37.74      95%      51.5399          0.54(    238)       38.99(       16)
STD DEV      12.1744   VARIANCE     148.216      50% MED     35.54      90%       41.874          8.68(     92)       39.88(       23)
SKEWNESS   -0.900844   KURTOSIS    0.775685      25% Q1      24.43      10%        9.864         10.16(     93)        40.5(      241)
USS          30222.1   CSS          3853.63       0% MIN      0.54       5%        3.796         12.46(    166)       47.37(        2)
CV           38.9572   STD MEAN     2.34297                              1%         0.54         18.18(     95)       54.32(      202)
T:MEAN=0     13.3381   PROB>|T|      0.0001     RANGE        53.78
SGN RANK         189   PROB>|S|      0.0001     Q3-Q1        13.31
NUM ^= 0          27                            MODE          29.8
W:NORMAL    0.902423   PROB<W         0.017

                                                MISSING VALUE          .
                                                        COUNT        226
                                                 % COUNT/NOBS      89.33

        STEM LEAF                     #         BOXPLOT                                NORMAL PROBABILITY PLOT
           5 4                        1            |            55+                                                         +    *
           4 007                      3            |              |                                                 + ++ *   *
           3 0012456667788899        16         *--+--*           |                                 ************* **
           2 44                       2         +-----+           |                            ****+++
           1 028                      3            |              |                  +  * **
           0 19                       2            0             5+            *   *
             ----+----+----+----+                                  +----+----+----+----+----+----+----+----+----+----+
             MULTIPLY STEM.LEAF BY 10**+01                                 -2        -1        +0        +1        +2
```

SAS

UNIVARIATE

VARIABLE=AL

MOMENTS

N	251	SUM WGTS	251
MEAN	0.76992	SUM	193.25
STD DEV	6.15232	VARIANCE	37.851
SKEWNESS	10.8582	KURTOSIS	122.956
USS	9611.54	CSS	9462.75
CV	799.085	STD MEAN	0.388331
T:MEAN=0	1.98264	PROB>|T|	0.0485022
SGN RANK	6342	PROB>|S|	0.0001
NUM ¬= 0	249		
D:NORMAL	0.445062	PROB>D	<0.01

QUANTILES(DEF=4)

100% MAX	77.1	99%	34.5831
75% Q3	0.11	95%	1.1
50% MED	0.03	90%	0.378
25% Q1	-0.02	10%	-0.08
0% MIN	-0.08	5%	-0.08
		1%	-0.08
RANGE	77.18		
Q3-Q1	0.13		
MODE	-0.08		

EXTREMES

LOWEST	ID	HIGHEST	ID
-0.08(	240)	9.1(	50)
-0.08(	245)	10.6(	50)
-0.08(	72)	13.8(	205)
-0.08(	166)	57.1(	208)
-0.08(	244)	77.1(	205)

MISSING VALUE .
COUNT 2
% COUNT/NOBS 0.79

```
      BAR CHART                                                          # BOXPLOT                 NORMAL PROBABILITY PLOT
 77.5+*                                                                  1     *      77.5+                                                        *
     .                                                                                    |
     .                                                                                    |
     .*                                                                  1     *           |                                                        *
     .                                                                                    |
     .                                                                                    |
 37.5+                                                                                37.5+
     .                                                                                    |
     .                                                                                    |
     .                                                                                    |                                                        +
     .*                                                                  2     *           |                                          +++++++**
     .*                                                                  1     *           |                                ++++++++++    *
     .***                                                               14  *--*--*        |                    **********************
 -2.5+*************************************************               232  +-----+   -2.5+***********************+
      ----+----+----+----+----+----+----+----+----+--                                  +----+----+----+----+----+----+----+----+----+----+
      * MAY REPRESENT UP TO 5 COUNTS                                                         -2        -1        +0        +1        +2
```

84

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                                                            SAS

                                                        UNIVARIATE

VARIABLE=BA

               MOMENTS                                          QUANTILES(DEF=4)                                       EXTREMES

N                239  SUM WGTS          239        100% MAX          2.8       99%   0.869986          LOWEST    ID         HIGHEST    ID
MEAN       0.0477197  SUM            11.405         75% Q3         0.028       95%        0.2          -0.005(   184)          0.33(   205)
STD DEV     0.203848  VARIANCE    0.0415539         50% MED         0.01       90%  0.0969996          -0.005(   108)          0.43(   205)
SKEWNESS     11.1237  KURTOSIS      143.352         25% Q1        -0.005       10%     -0.005          -0.005(   108)          0.54(    23)
USS          10.4341  CSS           9.88983          0% MIN       -0.005        5%     -0.005          -0.005(   181)          1.09(   100)
CV           427.178  STD MEAN    0.0131858                                     1%     -0.005          -0.005(    99)           2.8(    63)
T:MEAN=0     3.61902  PROB>|T|  .000361196       RANGE             2.805
SGN RANK       10699  PROB>|S|       0.0001       Q3-Q1             0.033
NUM ^= 0         239                              MODE             -0.005
D:NORMAL    0.397963  PROB>D          <0.01

                                                         MISSING VALUE        .
                                                                 COUNT       14
                                                          % COUNT/NOBS     5.53

          BAR CHART                                          #  BOXPLOT                       NORMAL PROBABILITY PLOT
    2.9+*                                                    1     *         2.9+                                                        *
       .                                                                        |
       .                                                                        |
    2.3+                                                                     2.3+
       .                                                                        |
       .                                                                        |
    1.7+                                                                     1.7+
       .                                                                        |
       .                                                                        |
    1.1+*                                                    1     *         1.1+                                                        *
       .                                                                        |
       .                                                                        |
    0.5+*                                                    2     *         0.5+                                               +++++** +
       .****                                                10     *            |                                     ++++++++******
       .*********************************************      134  *--*--*         |                            **********************
   -0.1+*******************************                     91  +-----+     -0.1+*************+******++++
        ----+----+----+----+----+----+----+----+----+                            +----+----+-- --+----+----+----+----+----+----+----+----+
        * MAY REPRESENT UP TO 3 COUNTS                                               -2        -1        +0        +1        +2
```

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                                                    SAS

                                                UNIVARIATE

VARIABLE=B

           MOMENTS                                         QUANTILES(DEF=4)                                      EXTREMES

N                249   SUM WGTS          249    100% MAX        3.9       99%         3.515        LOWEST     ID        HIGHEST     ID
MEAN        0.623273   SUM           155.195     75% Q3       0.905       95%           2.6        -0.02(    240)          3.5(     254)
STD DEV     0.796996   VARIANCE     0.635203     50% MED       0.36       90%          1.41        -0.02(     72)          3.5(     254)
SKEWNESS     2.00053   KURTOSIS      4.34182     25% Q1       0.039       10%        -0.005        -0.02(    239)         3.51(     257)
USS          254.259   CSS            157.53      0% MIN      -0.02        5%         -0.02        -0.02(    241)         3.52(     255)
CV           127.873   STD MEAN    0.0505076                               1%         -0.02        -0.02(    232)          3.9(     201)
T:MEAN=0     12.3402   PROB>|T|       0.0001    RANGE          3.92
SGN RANK 147[illegible].5   PROB>|S|       0.0001    Q3-Q1         0.866
NUM ^= 0         249                            MODE          -0.02
D:NORMAL 0.2[illegible]9798   PROB>D         <0.01

                                                 MISSING VALUE          .
                                                         COUNT          4
                                                  % COUNT/NOBS       1.58

             BAR CHART                               #      BOXPLOT                            NORMAL PROBABILITY PLOT
     3.9+*                                           1         *            3.9+                                                  *
        .                                                                      |
     3.5+***                                         6         *            3.5+                                          ***** *
        .                                                                      |
     3.1+*                                           2         0            3.1+                                        **
        .                                                                      |
     2.7+**                                          4         0            2.7+                                      ***      +
        .*                                           1         0               |                                      *     +
     2 3+*                                           2         0            2.3+                                     **  +++
        .                                                      |               |                                       ++
     1.9+*                                           2         |            1.9+                                     +++
        .*                                           1         |               |                                   ++
     1.5+****                                        7         |            1.5+                                 +++**
        .*******                                    14         |               |                               ++****
     1.1+*****                                      10         |            1.1+                            +++***
        .***************                            30      +-----+            |                          ++****
     0.7+************                               24      |  +  |         0.7+                       ++****
        .*********                                  17      |     |            |                     ++***
     0.3+***********                                21      *-----*         0.3+                  +++***
        .**********************************         68      +-----+            |             *********
    -0.1+********************                       39         |           -0.1+***************+++
         ----+----+----+----+----+----+----+----                                +----+----+----+----+----+----+----+----+----+----+
         * MAY REPRESENT UP TO 2 COUNTS                                              -2        -1        +0        +1        +2
```

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                                                                  SAS

                                                              UNIVARIATE

VARIABLE=CO

                  MOMENTS                                                    QUANTILES(DEF=4)                                      EXTREMES

N                 237    SUM WGTS          237         100% MAX       0.05        99%          0.05               LOWEST        HIGHEST
MEAN     -.00876793     SUM              -2.078          75% Q3        -0.01        95%          0.01               -0.03           0.02
STD DEV  0.00904936     VARIANCE .000081891             50% MED       -0.01        90%        -0.005              -0.02          0.025
SKEWNESS    4.18731     KURTOSIS      23.1042           25% Q1        -0.01        10%       -0.0104              -0.02           0.05
USS        0.037546     CSS         0.0193262            0% MIN       -0.03         5%         -0.02              -0.02           0.05
CV          -103.21     STD MEAN .000587819                                         1%         -0.02              -0.02           0.05
T:MEAN=0    -14.916     PROB>|T|       0.0001           RANGE          0.08
SGN RANK     -11914     PROB>|S|       0.0001           Q3-Q1             0
NUM ^= 0        237                                     MODE          -0.01
D:NORMAL   0.448663     PROB>D          <0.01

                                                        MISSING VALUE          .
                                                                COUNT         16
                                                         % COUNT/NOBS       6.32

          BAR CHART                                      # BOXPLOT                          NORMAL PROBABILITY PLOT
 0.0525+*                                                3   *     0.0525+                                                  ***
       .                                                                 |
       .                                                                 |
       .                                                                 |
       .                                                                 |
       .*                                                1   *           |                                                 *
       .*                                                3   *           |                                              ***
       .                                                                 |
 0.0125+**                                               5   *     0.0125+                                            *** +++++
       .*                                                2   *           |                                           *++++
       .                                                                 |                                     ++++++
       .*                                                3   *           |                                ++++   ***
       .**                                               8 *--+--*       |            ***************************
       .************************************************ 191  *           |           **      +++++
       .*                                                4   *           |***********  ++++++
       .****                                            16               |        +++++
-0.0275+*                                                1   *    -0.0275+++++++++
        ----+----+----+----+----+----+----+----+----+---                  +----+----+----+----+----+----+----+----+----+----+
        * MAY REPRESENT UP TO 4 COUNTS                                         -2        -1        +0        +1        +2
```

SAS

UNIVARIATE

VARIABLE=CR

```
                        MOMENTS

N               236      SUM WGTS          236
MEAN     0.00117797      SUM             0.278
STD DEV   0.0376602      VARIANCE   0.00141829
SKEWNESS    2.85898      KURTOSIS       12.202
USS        0.333626      CSS          0.333299
CV          3197.05      STD MEAN   0.00245147
T:MEAN=0   0.480514      PROB>|T|     0.631309
SGN RANK    -2841.5      PROB>|S|   0.00650322
NUM ^= 0        236
D:NORMAL   0.246376      PROB>D          <0.01
```

```
                   QUANTILES(DEF=4)

100% MAX      0.23          99%     0.197798
 75% Q3      0.007          95%         0.08
 50% MED    -0.003          90%    0.0329999
 25% Q1      -0.03          10%   -0.0318001
  0% MIN     -0.04           5%        -0.04
                             1%        -0.04
RANGE         0.27
Q3-Q1        0.037
MODE        -0.003

MISSING VALUE          .
     COUNT            17
% COUNT/NOBS        6.72
```

```
        EXTREMES

  LOWEST      HIGHEST
   -0.04          0.1
   -0.04         0.16
   -0.04         0.16
   -0.04         0.22
   -0.04         0.23
```

```
          BAR CHART                                          #      BOXPLOT
 0.235+*                                                     1         *
      .*                                                     1         *
      .
 0.205+
      .
      .
 0.175+
      .*                                                     2         *
      .
 0.145+
      .
      .
 0.115+
      .*                                                     1         0
      .**                                                    4         0
 0.085+**                                                    5         0
      .*                                                     1         0
      .*                                                     3         |
 0.055+*                                                     2         |
      .*                                                     3         |
      .**                                                    4         |
 0.025+****                                                 10         |
      .****                                                 12         |
      .********                                             22      +--+--+
-0.005+**********************************                  102      *-----*
      .*                                                     2      |     |
      .                                                             +-----+
-0.035+*********************                                61         |
       ----+----+----+----+----+----+----+----
       * MAY REPRESENT UP TO 3 COUNTS
```

```
                      NORMAL PROBABILITY PLOT
 0.235+                                                       *
      |                                                       *
      |
 0.205+
      |
      |
 0.175+
      |                                                    **
      |
 0.145+
      |
      |
 0.115+
      |                                                  *
      |                                               ***     +
 0.085+                                             **   +++
      |                                            *   ++
      |                                          **+++
 0.055+                                          +++
      |                                        ++**
      |                                      +++ **
 0.025+                                   +++ ***
      |                                 ++  ***
      |                              +++  ****
-0.005+                          ************
      |                            +++
      |                     *******+
-0.035+************+++++
       +----+----+----+----+----+----+----+----+----+----+
           -2        -1        +0        +1        +2
```

```
                                                                          SAS

                                                                      UNIVARIATE

VARIABLE=CU

                MOMENTS                                                QUANTILES(DEF=4)                                          EXTREMES

N                  235   SUM WGTS           235      100% MAX       0.11        99%    0.0855993          LOWEST      ID         HIGHEST      ID
MEAN       .000153191    SUM              0.036       75% Q3      -0.002        95%        0.026          -0.01(     240)         0.053(       42)
STD DEV     0.0146133    VARIANCE  .000213549        50% MED     -0.002        90%   0.00939999          -0.01(     245)          0.06(       41)
SKEWNESS      4.59054    KURTOSIS       25.5674       25% Q1      -0.006        10%       -0.006          -0.01(      72)          0.06(      205)
USS          0.049976    CSS          0.0499705        0% MIN      -0.01         5%        -0.01          -0.01(     166)           0.1(       51)
CV            9539.25    STD MEAN  .000953268                                   1%        -0.01          -0.01(     244)          0.11(      205)
T:MEAN=0     0.160701    PROB>|T|      0.872467      RANGE          0.12
SGN RANK      -6831.5    PROB>|S|        0.0001      Q3-Q1         0.004
NUM ^= 0          235                                MODE         -0.002
D:NORMAL     0.405378    PROB>D           <0.01

                                                                 MISSING VALUE           .
                                                                         COUNT          18
                                                                  % COUNT/NOBS        7.11

             BAR CHART                             #      BOXPLOT                              NORMAL PROBABILITY PLOT
     0.1125+*                                      1         *           0.1125+                                                   *
           .                                                                  |
           .*                                      1         *                |                                                   *
           .                                                                  |
           .                                                                  |
           .                                                                  |
           .                                                                  |
           .                                                                  |
           .                                                                  |
           .*                                      2         *                |                                                 **
           .                                                                  |
     0.0525+*                                      3         *           0.0525+                                             ***
           .                                                                  |
           .*                                      1         *                |                                            *
           .                                                                  |                                                   +
           .*                                      3         *                |                                           **  +++
           .*                                      1         *                |                                           *+++
           .*                                      3         *                |                                        +**+
           .*                                      1         *                |                                     +++ *
           .***                                    7         *                |                                 ++++ ***
           .****                                  10         0                |                              +++ ***
           .*                                      3         +                |                          ++++ **
           .*********************************     98      *-----*             |                       +*************
    -0.0075+**********************************   101      +-----+     -0.0075+************************
            ----+----+----+----+----+----+----                                 +----+----+----+----+----+----+----+----+----+----+
            * MAY REPRESENT UP TO 3 COUNTS                                          -2        -1        +0        +1        +2
```

SAS

UNIVARIATE

VARIABLE=FE

MOMENTS			
N	251	SUM WGTS	251
MEAN	1.31595	SUM	330.304
STD DEV	5.91103	VARIANCE	34.9403
SKEWNESS	7.08672	KURTOSIS	52.8924
USS	9169.75	CSS	8735.08
CV	449.183	STD MEAN	0.373101
T:MEAN=0	3.52707	PROB>|T|	.000499801
SGN RANK	15583.5	PROB>|S|	0.0001
NUM ^= 0	251		
D:NORMAL	0.407271	PROB>D	<0.01

QUANTILES(DEF=4)			
100% MAX	51.5	99%	47.716
75% Q3	0.25	95%	4.69999
50% MED	0.1	90%	1.946
25% Q1	0.05	10%	0.0124
0% MIN	-0.08	5%	-0.002
		1%	-0.01
RANGE	51.58		
Q3-Q1	0.2		
MODE	0.05		

EXTREMES			
LOWEST	ID	HIGHEST	ID
-0.08(	243)	15.4(	178)
-0.01(	166)	32.3(	205)
-0.01(	166)	46.9(	208)
-0.01(	125)	48.6(	205)
-0.01(	122)	51.5(	208)

MISSING VALUE	.
COUNT	2
% COUNT/NOBS	0.79

```
    BAR CHART                                           #   BOXPLOT          NORMAL PROBABILITY PLOT
 51+*                                                   1      *       51+                                                    *
   .*                                                   1      *         |                                                    *
   .*                                                   1      *         |                                                 *
   .                                                                     |
   .                                                                     |
   .                                                                     |
   .                                                                     |
   .                                                                     |
   .                                                                     |
   .*                                                   1      *         |                                               *
   .                                                                     |
   .                                                                     |
   .                                                                     |
 25+                                                                   25+
   .                                                                     |
   .                                                                     |
   .                                                                     |
   .                                                                     |                                                    +
   .*                                                   2      *         |                                              **++
   .                                                                     |                                              +++
   .*                                                   2      *         |                                          ++++
   .*                                                   3      *         |                                     +++     *
   .*                                                   3      *         |                                 ++++     **
   .***                                                11      *         |                             +++        **
   .*************************************************  154  *--*--*      |                         +++        ****
 -1+****************************                       72      |       -1+*********+++++++++++++
    ----+----+----+----+----+----+----+----                               +----+----+----+----+----+----+----+----+----+----+
    * MAY REPRESENT UP TO 4 COUNTS                                          -2        -1        +0        +1        +2
```

```
                                                    SAS

                                                UNIVARIATE

VARIABLE=LI

              MOMENTS                                      QUANTILES(DEF=4)                                       EXTREMES

N                  171   SUM WGTS           171      100% MAX       0.11     99%        0.11        OWEST     ID        HIGHEST     ID
MEAN      0.00022807   SUM              0.039       75% Q3        0.017     95%        0.04         -0.1(    108)         0.1(     182)
STD DEV    0.0307703   VARIANCE .000946812       50% MED      -0.006     90%        0.03         -0.1(    108)       0.103(     184)
SKEWNESS    0.864469   KURTOSIS     4.36261       25% Q1        -0.02     10%       -0.02         -0.1(    181)        0.11(     184)
USS         0.160967   CSS         0.160958        0% MIN        -0.1      5%       -0.02        -0.03(    120)        0.11(     195)
CV           13491.6   STD MEAN 0.00235306                                1%        -0.1        -0.02(    132)        0.11(     195)
T:MEAN=0   0.0969247   PROB>|T|      0.9229      RANGE          0.21
SGN RANK      -759.5   PROB>|S|    0.232046      Q3-Q1         0.037
NUM ^= 0         171                              MODE          -0.02
D:NORMAL    0.232074   PROB>D         <0.01

                                                 MISSING VALUE          .
                                                         COUNT         82
                                                  % COUNT/NOBS      32.41

          BAR CHART                                  #     BOXPLOT                           NORMAL PROBABILITY PLOT
  0.115+**                                           3        0        0.115+                                                   ****
       .**                                           3        0             |                                              ***
       .                                                                    |
       .                                                                    |
       .                                                                    |                                                    +++
       .*                                                                   |                                              +  +
  0.045+**                                           1        |             |                                            +++
       .******                                       4        |        0.045+                                         ++***
       .**********                                  11        |             |                                     +*****
       .****************                            19        |             |                                  *****
       .*****                                       31     +-----+          |                            ******
       .****                                         9     |  +  |          |                        +*++
       .                                             8     *-----*          |                     +++**
-0.025+************************************                |     |          |                  +++
       .*                                           78     +-----+     -0.025+    *****************
       .                                             1        |             |    *     ++++
       .                                                                    |      +++
       .                                                                    |   +++
       .                                                                    | +  +
       .                                                                    |+++
-0.095+**                                            3        0             |
       ----+----+----+----+----+----+----+----                        -0.095+****
       * MAY REPRESENT UP TO 2 COUNTS                                        +----+----+----+----+----+----+----+----+----+----+
                                                                                  -2        -1        +0        +1        +2
```

SAS

UNIVARIATE

VARIABLE=MN

MOMENTS

N	236	SUM WGTS	236
MEAN	0.0564831	SUM	13.33
STD DEV	0.248646	VARIANCE	0.0618247
SKEWNESS	6.48375	KURTOSIS	56.0104
USS	15.2817	CSS	14.5288
CV	440.213	STD MEAN	0.0161855
T:MEAN=0	3.48974	PROB>|T|	.000577201
SGN RANK	4300.5	PROB>|S|	0.0001
NUM ^= 0	236		
D:NORMAL	0.325779	PROB>D	<0.01

QUANTILES(DEF=4)

100% MAX	2.3	99%	1.78196
75% Q3	0.05	95%	0.343
50% MED	0.004	90%	0.263
25% Q1	-0.02	10%	-0.02
0% MIN	-0.5	5%	-0.1
		1%	-0.5
RANGE	2.8		
Q3-Q1	0.07		
MODE	-0.02		

EXTREMES

LOWEST	ID	HIGHEST	ID
-0.5(	29)	0.47(	180)
-0.5(	29)	0.6(	205)
-0.5(	23)	0.9(	205)
-0.1(	184)	2.3(	208)
-0.1(	108)	2.3(	208)

MISSING VALUE .
COUNT 17
% COUNT/NOBS 6.72

```
       BAR CHART                                              #    BOXPLOT
  2.3+*                                                       2      *
     .
     .
     .
     .
     .
     .
  0.9+*                                                       1      *
     .*                                                       1      *
     .*                                                       2      *
     .*******                                                21      *
     .*****************************                          87   *--0--*
     .****************************************              119   +-----+
     .
 -0.5+*                                                       3      *
      ----+----+----+----+----+----+----+----+
      * MAY REPRESENT UP TO 3 COUNTS
```

```
                         NORMAL PROBABILITY PLOT
  2.3+                                                          *
     |
     |
     |
     |
     |
     |
  0.9+                                                       *
     |                                                     *+ +
     |                                               ++++++**
     |                                   +++++*********
     |                         ++*************
     |   *********************
     |       ++++++++
 -0.5+***++++
      +----+----+----+----+----+----+----+----+----+----+
          -2        -1        +0        +1        +2
```

SAS

UNIVARIATE

VARIABLE=MO

MOMENTS

N	237	SUM WGTS	237
MEAN	0.172532	SUM	40.89
STD DEV	0.273735	VARIANCE	0.0749309
SKEWNESS	1.60339	KURTOSIS	1.93171
USS	24.7385	CSS	17.6837
CV	158.658	STD MEAN	0.017781
T:MEAN=0	9.70315	PROB>|T|	0.0001
SGN RANK	8042	PROB>|S|	0.0001
NUM ^= 0	237		
D:NORMAL	0.221247	PROB>D	<0.01

QUANTILES(DEF=4)

100% MAX	1.22	99%	0.9862
75% Q3	0.26	95%	0.834
50% MED	0.07	90%	0.61
25% Q1	-0.03	10%	-0.03
0% MIN	-0.1	5%	-0.03
		1%	-0.0734
RANGE	1.32		
Q3-Q1	0.29		
MODE	-0.03		

EXTREMES

LOWEST	ID	HIGHEST	ID
-0.1(	2)	0.98(	40)
-0.1(	2)	0.98(	40)
-0.03(	184)	0.98(	180)
-0.03(	181)	0.99(	180)
-0.03(	108)	1.22(	182)

MISSING VALUE .
COUNT 16
% COUNT/NOBS 6.32

```
           BAR CHART                                      #    BOXPLOT
  1.225+*                                                 1       *
       .
       .
       .
       .
       .**                                                4       0
       .**                                                5       0
       .*                                                 1       0
       .**                                                5       0
       .*                                                 1       0
       .*                                                 2       0
       .*                                                 1       |
       .***                                               7       |
  0.575+*                                                 1       |
       .**                                                5       |
       .*                                                 3       |
       .**                                                5       |
       .*                                                 1       |
       .**                                                4       |
       .******                                           17    +-----+
       .******                                           16    |     |
       .******                                           18    |  +  |
       .*******                                          21    |     |
       .**                                                6    *-----*
       .**                                                4    |     |
       .************************************            107    +-----+
 -0.075+*                                                 2       |
        ----+----+----+----+----+----+----+-
        * MAY REPRESENT UP TO 3 COUNTS
```

```
                       NORMAL PROBABILITY PLOT
  1.225+                                                  *
       |
       |
       |
       |
       |                                              *** *
       |                                          ****
       |                                          *       +
       |                                        ***     +
       |                                        *      +
       |                                       *     ++
       |                                       *   ++
       |                                     *** ++
  0.575+                                     * ++
       |                                    *++
       |                                   *+
       |                                  *+
       |                                ++*
       |                              ++  *
       |                            ++ ****
       |                           + ***
       |                         ++***
       |                       ++***
       |                     ++ **
       |                   ++   *
       |  ***********************
 -0.075+* +++++++++++++++
        +----+----+----+----+----+----+----+----+----+----+
             -2        -1        +0        +1        +2
```

```
                                                       SAS

                                                   UNIVARIATE

VARIABLE=NI

              MOMENTS                                          QUANTILES(DEF=4)                                     EXTREMES

N                 212  SUM WGTS          212      100% MAX        0.16      99%     0.136998        LOWEST      ID        HIGHEST     ID
MEAN       -0.0165472  SUM            -3.508       75% Q3        -0.02      95%         0.01        -0.03(     240)        0.03(     187)
STD DEV     0.0201944  VARIANCE  .000407813       50% MED       -0.02      90%        -0.01        -0.03(     245)        0.04(      41)
SKEWNESS       6.3953  KURTOSIS       49.475       25% Q1        -0.02      10%        -0.03        -0.03(      72)        0.05(     127)
USS          0.144096  CSS         0.0860485        0% MIN       -0.03       5%        -0.03        -0.03(     166)        0.15(     208)
CV           -122.041  STD MEAN   0.00138696                               1%        -0.03        -0.03(     244)        0.16(     208)
T:MEAN=0     -11.9306  PROB>|T|       0.0001      RANGE           0.19
SGN RANK      -9615.5  PROB>|S|       0.0001      Q3-Q1              0
NUM ^= 0          212                             MODE           -0.02
D:NORMAL      0.42637  PROB>D          <0.01

                                                  MISSING VALUE        .
                                                          COUNT       41
                                                   % COUNT/NOBS    16.21

           BAR CHART                                         #  BOXPLOT                      NORMAL PROBABILITY PLOT
  0.165+*                                                    1     *       0.165+                                                         *
       .*                                                    1     *            |                                                       *
       .                                                                        |
       .                                                                        |
       .                                                                        |
       .                                                                        |
       .                                                                        |
       .                                                                        |
       .                                                                        |
       .                                                                        |
       .                                                                        |
       .*                                                    1     *            |                                                    *
       .*                                                    1     *            |                                                   *
       .*                                                    3     *            |                                                 **    ++
       .*                                                    2     *            |                                               **++++
       .*                                                    4     *            |                                            ++*++
       .                                                                        |                                        +++++
       .*                                                    3     *            |                                   +++++  *****
       .****                                                14  *--+--*         |              ***********************
 -0.025+*********************************************      182     *      -0.025+**************++++++++++
        ----+----+----+----+----+----+----+----+----+-                          +----+----+----+----+----+----+----+----+----+----+
        * MAY REPRESENT UP TO 4 COUNTS                                               -2        -1        +0        +1        +2
```

SAS

UNIVARIATE

VARIABLE=PB

MOMENTS			
N	216	SUM WGTS	216
MEAN	-0.0652731	SUM	-14.099
STD DEV	0.162706	VARIANCE	0.0264733
SKEWNESS	4.54587	KURTOSIS	28.3277
USS	6.61205	CSS	5.69176
CV	-249.27	STD MEAN	0.0110708
T:MEAN=0	-5.896	PROB>|T|	0.0001
SGN RANK	-6786.5	PROB>|S|	0.0001
NUM ^= 0	216		
D:NORMAL	0.422468	PROB>D	<0.01

QUANTILES(DEF=4)			
100% MAX	1.3	99%	0.809197
75% Q3	-0.1	95%	0.196
50% MED	-0.1	90%	0.126
25% Q1	-0.15	10%	-0.15
0% MIN	-0.16	5%	-0.15
		1%	-0.16
RANGE	1.46		
Q3-Q1	0.05		
MODE	-0.1		

EXTREMES			
LOWEST	ID	HIGHEST	ID
-0.16(	109)	0.37(	127)
-0.16(	187)	0.4(	208)
-0.16(	109)	0.61(	180)
-0.16(	187)	0.85(	205)
-0.15(	240)	1.3(	205)

MISSING VALUE .
COUNT 37
% COUNT/NOBS 14.62

```
        BAR CHART                                                   #   BOXPLOT
  1.35+*                                                            1      *
      .
      .
  1.05+
      .
      .*                                                            1      *
  0.75+
      .*                                                            1      *
      .
  0.45+*                                                            1      *
      .*                                                            4      *
      .*                                                            2      *
  0.15+*****                                                       19      *
      .
      .**                                                           6   *--0--*
 -0.15+**********************************************             181   +-----+
       ----+----+----+----+----+----+----+----+----+--
       * MAY REPRESENT UP TO 4 COUNTS
```

```
                            NORMAL PROBABILITY PLOT
  1.35+                                                                  *
      |
      |
  1.05+
      |
      |                                                                *
  0.75+
      |                                                              *
      |
  0.45+                                                            *
      |                                                         ***  +++
      |                                                        *++++
  0.15+                                                  *******
      |                                             ++++++
      |                                   ****************
 -0.15+*********************++
       +----+----+----+----+----+----+----+----+----+----+
            -2        -1        +0        +1        +2
```

SAS

UNIVARIATE

VARIABLE=SR

MOMENTS

N	210	SUM WGTS	210
MEAN	0.0256143	SUM	5.379
STD DEV	0.0317883	VARIANCE	0.0010105
SKEWNESS	2.75017	KURTOSIS	11.2513
USS	0.348973	CSS	0.211194
CV	124.104	STD MEAN	0.0021936
T:MEAN=0	11.6768	PROB>|T|	0.0001
SGN RANK	10765	PROB>|S|	0.0001
NUM ~= 0	209		
D:NORMAL	0.231999	PROB>D	<0.01

QUANTILES(DEF=4)

100% MAX	0.217	99%	0.200099
75% Q3	0.04	95%	0.0745499
50% MED	0.012	90%	0.061
25% Q1	0.007	10%	0.00209999
0% MIN	-0.012	5%	-0.001
		1%	-0.003
RANGE	0.229		
Q3-Q1	0.033		
MODE	0.01		

EXTREMES

LOWEST	ID	HIGHEST	ID
-0.012(	102)	0.118(	260)
-0.003(	245)	0.119(	205)
-0.003(	243)	0.12(	39)
-0.001(	51)	0.21(	207)
-0.001(	218)	0.217(	205)

MISSING VALUE .
COUNT 43
% COUNT/NOBS 17.00

```
           BAR CHART                                    #      BOXPLOT                          NORMAL PROBABILITY PLOT
  0.215+*                                               2         *          0.215+                                                            **
       .                                                                          |
       .                                                                          |
       .                                                                          |
       .                                                                          |
       .                                                                          |
       .                                                                          |
       .                                                                          |
       .                                                                          |
       .*                                               1                         |
       .**                                              3         0               |                                                      ****
       .*                                               2         0               |                                                     **    ++
       .*                                               1                         |                                                        ++
       .*                                               1         0               |                                                   ****+
       .                                                          |               |                                                ++++
       .***********                                    21         |               |                                            ******
       .*****                                          10         |               |                                         +**
       .*******                                        13      +-----+            |                                      ++**
       .*******                                        13      |     |            |                                   +++**
       .*****                                          10      |  +  |            |                                +++ ***
       .*****************************                  57      *-----*            |                             ++******
       .*******************************                62      +-----+            |                  ***************
       .*******                                        13         |               | **********    +++
 -0.015+*                                               1         |        -0.015+*+++++++++++++
        ----+----+----+----+----+----+-                                           +----+----+----+----+----+----+----+----+----+----+
        * MAY REPRESENT UP TO 2 COUNTS                                                 -2        -1        +0        +1        +2
```

96

SAS

UNIVARIATE

VARIABLE=ZN

MOMENTS

N	235	SUM WGTS	235
MEAN	0.0708	SUM	16.638
STD DEV	0.386155	VARIANCE	0.149116
SKEWNESS	7.39072	KURTOSIS	55.6158
USS	36.071	CSS	34.893
CV	545.416	STD MEAN	0.02519
T:MEAN=0	2.81064	PROB>|T|	0.00536306
SGN RANK	3149.5	PROB>|S|	0.00242892
NUM ^= 0	235		
D:NORMAL	0.407051	PROB>D	<0.01

QUANTILES(DEF=4)

100% MAX	3.4	99%	3.0496
75% Q3	0.029	95%	0.15
50% MED	-0.002	90%	0.0839999
25% Q1	-0.01	10%	-0.01
0% MIN	-0.02	5%	-0.015
		1%	-0.02
RANGE	3.42		
Q3-Q1	0.039		
MODE	-0.01		

EXTREMES

LOWEST	ID	HIGHEST	ID
-0.02(	5)	0.62(	50)
-0.02(	187)	2.2(	205)
-0.02(	5)	2.96(	205)
-0.02(	187)	3.1(	208)
-0.02(	132)	3.4(	208)

MISSING VALUE .
COUNT 18
% COUNT/NOBS 7.11

```
      BAR CHART                                                     # BOXPLOT
 3.5+*                                                              1    *
    .
    .*                                                              1    *
    .*                                                              1    *
    .
    .
    .*                                                              1    *
    .
    .
 1.7+
    .
    .
    .
    .
    .*                                                              2    *
    .
    .**                                                             4    *
    .****************************                                  86 +--*--+
-0.1+**********************************************************   139 *-----*
     ----+----+----+----+----+----+----+----+----+--
     * MAY REPRESENT UP TO 3 COUNTS
```

```
                      NORMAL PROBABILITY PLOT
 3.5+                                                     *
    |
    |                                                     *
    |                                                   *
    |
    |
    |                                                  *
    |
    |
 1.7+
    |
    |
    |
    |                                                     +
    |                                                +++++
    |                                           +++++ **
    |                                      +++++
    |                                 +++++        ***
    |                            +++****************
-0.1+****************************
     +----+----+----+----+----+----+----+----+----+----+
         -2        -1        +0        +1        +2
```

WILLIAMS & ASSOCIATES, INC.

P.O. Box 48, Viola, Idaho 83872 (208) 883-0153 (208) 875-0147

Hydrogeology • Mineral Resources Waste Management • Geological Engineering • Mine Hydrology

WM-RES
WM Record File
B-7372
WdA

WM Project 10
Docket No.
PDR ✓
LPDR B

Distribution:
M. GORDON
Jerry Tricket

(Return to WM, 623-SS)
Z3

June 27, 1985
Contract NRC-02-82-044
FIN # B7372-3
Communication #131

Mr. Matthew Gordon
Division of Waste Management
Mail Stop 623-SS
U. S. Nuclear Regulatory Commission
Washington, D. C. 20555

Dear Matt:

Two copies of the second draft of our statistical analysis of the hydrochemical data are enclosed. We believe that the questions raised about the first draft have been addressed either in this draft or in our discussions. Please call if you have any questions. We will submit the final draft of this report when we receive your comments on this second draft.

Sincerely,

Gerry

Gerry Winter

WM DOCKET CONTROL CENTER
'85 JUN 31 A10:46