UNITED STATES DEPARTMENT OF THE INTERIOR
GEOLOGICAL SURVEY

Radioactivity and geochemistry of selected mineral-spring waters in the Western United States--Basic data and multivariate statistical analysis

By

J. Karen Felmlee and Robert A. Cadigan

Open-File Report 82-324

1982

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

Contents

Page

Illustrations

Tables

Abstract

Multivariate statistical analyses were performed on data from 156 mineral-spring sites in nine Western States to analyze relationships among the various parameters measured in the spring waters. Correlation analysis and R-mode factor analysis indicate that three major factors affect water composition in the spring systems studied: (1) duration of water circulation, (2) depth of water circulation, and (3) partial pressure of carbon dioxide. An examination of factor scores indicates that several types of hydrogeologic systems were sampled. Most of the samples are (1) older water from deeper circulating systems having relatively high salinity, high temperature, and low Eh or (2) younger water from shallower circulating systems having relatively low salinity, low temperature, and high Eh. The rest of the samples are from more complex systems. Any of the systems can have a relatively high or low content of dissolved carbonate species, resulting in a low or high pH, respectively. Uranium concentrations are commonly higher in waters of relatively low temperature and high Eh, and radium concentrations are commonly higher in waters having a relatively high carbonate content (low pH) and, secondarily, relatively high salinity.

Water samples were collected and (or) measurements were taken at 156 of the 171 mineral-spring sites visited. Various samples were analyzed for radium, uranium, radon, helium, and radium-228 as well as major ions and numerous trace elements. On-site measurements for physical properties including temperature, specific conductance, pH, Eh, and dissolved oxygen were made. All constituents and properties show a wide range of values. Radium concentrations range from less than 0.01 to 300 picocuries per liter; they average 1.48 picocuries per liter and have an anomaly threshold value of 171

picocuries per liter for the samples studied. Uranium concentrations range from less than 0.01 to 120 micrograms per liter and average 0.26 micrograms per liter; they have an anomaly threshold value of 48.1 micrograms per liter. Radon content ranges from less than 10 to 110,000 picocuries per liter, averages 549 picocuries per liter and and has an anomaly threshold of 20,400 picocuries per liter. Helium content ranges from -1,300 to +13,000 parts per billion relative to atmospheric helium; it averages +725 parts per billion and has an anomaly threshold of 10,000 parts per billion. Radium-228 concentrations range from less than 2.0 to 33 picocuries per liter; no anomaly threshold was determined owing to the small number of samples. All of the anomaly thresholds may be somewhat high because the sampling was biased toward springs likely to be radioactive.

The statistical variance in radium and uranium concentrations unaccounted for by the identified factors testifies to the complexity of some hydrogeologic systems. Unidentified factors related to geologic setting and the presence of uranium-rich rocks in the systems also affect the observed concentrations of the radioactive elements in the water. The association of anomalous radioactivity in several springs with nearby known uranium occurences indicates that other springs having anomalous radioactivity may also be associated with uranium occurrences as yet undiscovered.

Introduction

Purpose of study

Mineral springs have fascinated mankind for centuries and have long been used for medicinal purposes. Only recently has modern science sought to determine the origin of such springs and found ways to utilize the water or precipitates for various other commercial purposes. Thermal mineral springs have been studied as possible geothermal energy sources. Minerals precipitated by spring waters have been mined for the metals they contain or for their quality as ornamental stone. Some mineral springs have provided insights into the nature of hydrothermal ore-forming solutions.

Our study was undertaken to examine the geochemical environment of radioactive mineral springs and to determine if the properties of the springs could be used as geochemical tools in uranium exploration. Data on numerous radioactive and nonradioactive parameters for both water and precipitates from a variety of springs were gathered and interpreted.

This report presents the data pertaining to the water at the springs studied. It emphasizes the radioactive properties of the mineral-spring waters and speculates on the relationship between the radioactivity in the waters and the source of radioactivity in the rocks of the associated hydrogeologic systems. It discusses the relationships among all the measured parameters, as determined by multivariate statistical analysis, and interprets the major factors affecting the geochemistry of the spring systems.

Sampling was directed toward "mineral springs" as opposed to common fresh-water springs. By definition, a mineral spring is "a spring whose water contains enough mineral matter to give it a definite taste, in comparison to ordinary drinking water, especially if the taste is unpleasant or if the water is regarded as having therapeutic value" (Gary and others, 1974). The minimum amount of mineral matter necessary to impart a taste is not stated, presumably because the amount is variable and depends on the ions or gases involved. Water containing more than 1,000 mg/L (milligrams per liter) total dissolved solids is usually considered undesirable for drinking; therefore, most saline springs can be called mineral waters. Thermal springs are commonly used as health spas and are considered to be mineral water even though the total dissolved-solids content may be less than 1,000 mg/L. In an effort to examine a variety of mineral springs, the literature and maps were searched for references to spas or resorts and to hot springs, warm springs, salt springs, soda springs, and sulfur springs. Many mineral springs in widely scattered localities were visited, as well as fresh-water springs in some areas. The springs sampled range in dissolved-solids content from 83 to 35,000 mg/L and in temperature from 6°C to 94°C.

Area of study

From 1975 to 1980, 171 spring sites were visited in nine Western States. Water samples were collected and (or) measurements were taken at 156 sites; precipitate or sediment samples were taken at 97 sites. The distribution of sites by State is shown in the following table:

State	Total sites	Water sites	Precipitate sites
Arizona---------------	18	10	14
California------------	10	10	4
Colorado--------------	28	23	22
Idaho-----------------	6	6	4
Montana---------------	14	14	6
Nevada----------------	36	35	17
New Mexico------------	5	5	2
Utah------------------	44	43	20
Wyoming---------------	10	10	8
All States-------	171	156	97

Mineral-spring sites visited during this study are shown on figure 1 and listed in table 1. Fifteen sites in Arizona were visited by colleagues who collected samples along the Colorado River in the Grand Canyon (Peterson and others, 1977). We visited all the other sites, took various on-site measurements, and collected water or precipitate samples where appropriate. Two of the sites (one in Idaho and one in Nevada) are not shown on the map because the samples were taken with the permission of the property owners on the condition that the sample locations be considered confidential.

Water sample localities are shown on figure 2. As mentioned above, this report discusses only the water data from the mineral-spring sites visited.

Previous work

Many workers have studied both radioactive and nonradioactive properties of mineral springs and other subsurface waters. Reports by Boltwood (1905), Schlundt and Moore (1909), Scott and Barker (1962), and White, Hem, and Waring (1963) contributed much toward an early understanding of the distribution and origin of radium, uranium, and major elements in springs and subsurface waters in the United States. More recent studies in the Western United States have expanded our understanding. A study by Wollenberg (1974) yielded information on radioactivity in spring waters and in their calcareous and siliceous precipitates. Other work by O'Connell and Kaufmann (1976) and Barrett and Pearl (1976) provided data on radioactive isotopes in thermal springs. Numerous other reports have investigated the nonradioactive properties and constituents of hot or cold mineral springs in the West. Among these are reports by Mundorff (1970, 1971); Mallory and Barnett (1973); Young and Mitchell (1973); Sanders and Miles (1974); Chadwick and Kaczmarek (1975); Mariner, Presser, and Evans (1976, 1977); and Feth and Barnes (1979).

Acknowledgments

We express our thanks to the many property owners who permitted us to sample their springs. We also thank the following people for their contributions to the study: James E. Peterson, S. Eugene Buell, and Charles S. Spirakis for their work in the Grand Canyon; Brenda A. Steele-Mallory, Cheryl W. Adkisson, and Robin E. Glanville for their assistance in field work; and Cheryl W. Adkisson and Barbara Dodge for their assistance in computer processing of the data. Some of the laboratory analytical work was done by Paul R. Barnett and L. Mei (some spectrographic analyses), Oliver J. Feist, Jr. (some radium analyses), G. Michael Reimer (all helium analyses), and Marian Schnepfe (some uranium analyses). Most other laboratory work was done by various people under the supervision of Earl S. Skinner at the U.S. Geological Survey Water Resources Division Central Laboratories.

Methods of study

During the course of this study several changes were made in the types of field measurements done, in the methods of sample collection and treatment for some elements, in the methods of sample analysis for some elements, and in the number of elements analyzed. Some changes were necessitated by changes in the capabilities and procedures of the U.S. Geological Survey laboratories where the samples were analyzed. Other changes were judged desirable as new information became available. As a result, the data set is an incomplete one; that is, not all samples have data for all variables. Also, data for some parameters were obtained by different methods, and they had to be tested for comparability before being combined and used in statistical analysis. Specific problems are discussed where appropriate.

Field measurements, sample collection, and laboratory analysis

Temperature, pH, and specific conductance were measured in the field at all sites. Temperature was measured at the surface as near the source of each spring as possible and was recorded to the nearest degree celsius. The pH was measured by means of a combination glass electrode with a silver/silver chloride reference and was recorded to the nearest tenth of a pH unit. Specific conductance was measured using standard instrumentation that compensates for temperature and standardizes the reading to 25°C.

Dissolved oxygen and (or) oxidation-reduction potential were measured in the field at some of the sites. Dissolved oxygen was measured using a probe with a potassium chloride solution and a membrane filter. The probe was calibrated in air-saturated water, and readings were corrected for altitude. The probe was submerged a few centimeters to a meter in the spring pool, depending on pool depth, or held in running water emerging from an orifice. Oxidation-reduction potential, or Eh, was measured using a combination platinum electrode with a silver-saturated chloride reference solution. The tip of the electrode was held a few centimeters below the surface of the pool or the running water. A period of 5-10 minutes was allowed for the meter reading to stabilize. Some readings stabalized immediately, but others drifted downward rapidly and then slowly approached equilibrium; the reading was taken at the change in rate.

Sodium, chloride, fluoride, and divalent cations (calcium and magnesium) were measured in the field at various sites using specific-ion electrodes. A 100-ml (milliliter) sample or a 1- or 10-ml sample diluted to 100 ml with distilled water was used for most analyses. A 50-ml sample diluted to 100 ml with a buffering solution was used for fluoride analyses. A known-addition technique involving standard solutions was used to determine ion concentrations.

Radium-analyses were done by two similar radiochemical methods. At most sites a 1-liter sample of untreated water was collected and was later analyzed in the laboratory by the carrier-precipitation radon method. In this method the radium is coprecipitated with barium sulfate, the precipitate is centrifuged and then dissolved, and the solution is purged with helium to remove existing radon. The solution is then allowed to equilibrate for 2-20 days, after which it is again purged with helium, and an alpha count is taken on the recovered radon-222. Radium-226 is then calculated. As a result of temporary administrative constraints, many of the 1-liter untreated samples, mostly those collected in Nevada, were analyzed by the carrier-precipitation planchet method. In this method the radium is coprecipitated with barium sulfate, and the precipitate is collected on a filter, or planchet. The planchet is allowed to equilibrate for at least 15 days before an alpha count is taken. Total radium is then calculated. Both of the above methods are discussed in Thatcher, Janzer, and Edwards (1977). At some sites, mostly those visited late in the study, a 1-liter sample of water was filtered through a 0.45-µm (micrometer) membrane and then acidified with 2 ml of concentrated hydrochloric acid or 2 ml of 6 N nitric acid in the field. These samples were later analyzed for radium-226 by the radon method.

Analyses for radium-228 were done on a selected number of 1-liter untreated samples by a method involving separation and counting of actinium-228, as discussed in Thatcher, Janzer, and Edwards (1977). Chemical separation is achieved using a series of precipitations and digestions with lead, barium, and yttrium carrier solutions. A beta count is done on the actinium-228, and the radium-228 is then calculated.

Uranium analyses were done by fluorometric methods. At most sites a 1-liter sample of untreated water was taken. These samples were later analyzed in the laboratory by direct fluorometry and then, if necessary, by extraction fluorometry; those samples showing less than 30 percent quenching or those having uranium contents above 0.3 μg/L (micrograms per liter) by the direct method did not require further analysis by the extraction method. The direct method involves evaporating a water sample to dryness and then fusing the residue with a fluoride-carbonate flux. The fluorescence of the fused disk is determined under ultraviolet light in a reflection-type fluorometer. The extraction method involves preconcentrating the uranium by coprecipitation with aluminum phosphate. The precipitate is then dissolved in dilute nitric acid, the uranium is extracted with ethyl acetate or ethyl ether, and the solution is then evaporated, fused, and fluoresced. Both the direct and the extraction methods are discussed in Thatcher, Janzer, and Edwards (1977). At numerous sites a 1-liter sample was filtered through a 0.45-μm membrane and then acidified in the field with 2 ml of 6 N nitric acid (mostly samples from Nevada) or of concentrated hydrochloric acid (mostly samples collected late in the study). These samples were analyzed by fluorometric methods also.

Radon was measured in the field using a modified alpha spectrometer

(Reimer, 1977) which had been calibrated with a 100-pCi/L standard. For each determination, a 2-liter sample of water was collected in a 2.8-liter plastic container; at some sites a 0.75-liter sample of water was collected in a 1-liter container. The lid was sealed, and the container was shaken vigorously for 1 minute. Using a syringe, a 50-ml sample of the air-gas mixture in the top of the container was taken through a self-sealing valve in the lid. The gas sample was then inserted into a partial vacuum in the alpha-counting chamber of the spectrometer. The sample was counted for 1 minute, recounted after a 1-minute wait, and then recounted after a 2-minute wait. The last count was corrected back to a time of 1 minute and then adjusted mathematically to obtain the value of radon-222 in picocuries per liter.

Helium samples were taken at a few sites and analyzed later by mass spectrometer. A 0.75-liter sample of water was collected in a 1-liter container and shaken vigorously for 1 minute. A 20-ml sample of the air-gas mixture was drawn from the container using a syringe, and the sample was then injected into a vacuumized stainless steel cylinder for transport to the laboratory.

Samples for analysis of major ions and trace-element constituents were taken at most sites. A 1-liter sample filtered through a 0.45-µm membrane and acidified with 2 ml of 6 N nitric acid was collected for analysis of major cations; a 250-ml sample, filtered but not acidified, was collected for major anions; a 250-ml untreated sample was collected for alkalinity and for laboratory pH and specific conductance; and a 1- or 4-liter sample filtered and acidified with nitric acid was collected for analysis of minor elements. At some of the sites, particularly those visited early in the study, samples were not collected. Instead, we have used published data available from recent sampling by other investigators whose analyses were done in U.S. Geological Survey laboratories, as noted in table 2 of this report.

Trace-element constituents of the water were analyzed by SPEC (emission spectrography), AA (atomic absorption spectroscopy), ICP (inductively coupled plasma spectroscopy), or WC(wet-chemistry) methods. Changes in administrative policy necessitated a change from one laboratory in the U.S. Geological Survey to another during part of the study. Semi-quantitative SPEC analyses were done by both laboratories. However, different suites of elements were determined, so Sb, La, Nd, Sc, W, Yb, and Y were determined in one laboratory but not the other. Although detection limits for Al and Fe were so high in one laboratory that no values greater than the detection limit were reported, WC data were reported for these elements.

Changes in laboratory procedures necessitated a change from a SPEC to an ICP method of analysis for many trace elements during the latter part of the study. A semi-quantitative ICP method was chosen over a quantitative one because the suite of elements to be determined was more consistent with the suite determined by the semi-quantitative SPEC method. Subsequently it became apparent that the semi-quantitative ICP data have a larger variance than the semi-quantitative SPEC data, and consequently some of the ICP data were suitable for statistical purposes and some were not, as discussed below.

Evaluation of results

The use of different methods of sample treatment and analysis during the course of this study, as well as the use of published data, has necessitated an evaluation of the comparability of analytical results obtained by these different methods before the data could be combined for use in statistical analysis. As discussed below, the variations attributed to different methods were considered acceptable for most results, but the variations in some results were considered excessive. Data with excessive variations were omitted from table 2 and from the statistical procedures.

Samples analyzed for radium-226 by the radon method but collected by different procedures yielded similar analytical results in this study, as indicated by duplicate samples collected at three sites. At Baker Hot Springs (UT23) an untreated sample and a filtered sample acidified with hydrochloric acid yielded 3.5 and 3.6 pCi/L radium, respectively. At Utah Hot Springs (UT10) an untreated sample and a filtered sample acidified with nitric acid had 66 and 69 pCi/L, respectively, and at Stinking Springs near Manti (UT36A) an untreated sample and a filtered sample acidified with nitric acid had 38 and 36 pCi/L, respectively. Such small variations in analytical results on these samples indicate that radium values determined on other samples treated in these different ways can be treated as one population for statistical analysis.

Samples analyzed for radium-226 by the radon method and for total radium by the planchet method yielded compatible results at high concentrations but somewhat less compatible results at lower concentrations. The concentration of radium-226 should be equal to or less than the concentration of total radium at any one spring, the difference in values being made up by radium-228. Direct comparison of all three values was possible at only one site. At Monte Neva Hot Springs (NV18) samples yielded 110 pCi/L radium-226, 120 pCi/L total radium, and 33 pCi/L radium-228. Although the radium-226 and radium-228 add up to more than the value for total radium, these results are compatible within the limits of precision of the methods used (±10 percent for radium-226 and radium-228 and ±20 percent for total radium). Direct comparison of values for radium-226 and total radium was possible at only one other site. At Wilson Health Springs (UT18) samples yielded 130 pCi/L for both radium-226 and total radium. Apparently, at these high concentrations of radium, radium-228 constitutes a relatively small proportion of the total radium, so the values for radium-226 and total radium are similar. Direct comparison of values for radium-226 and radium-228 was possible at several other sites. At most of those sites, radium-226 exceeded radium-228, but at some sites in Montana, samples yielded relatively greater proportions of radium-228; for example, at Jardine Hot Spring (MT13), values are 3.7 pCi/L radium-226 and 5.7 pCi/L radium-228, giving a value for total radium of about 9.4 pCi/L. Apparently, at these lower concentrations, the values for radium-226 and for total radium are no longer equal or nearly so, although they are still the same order of magnitude. Additional sampling of radium-226, radium-228, and total radium at a number of other sites is needed to better judge the expected variation in measured concentrations of radium-226 and total radium. For this report the concentrations were judged to be similar enough for use in statistical analysis, so values for radium-226 and total radium have both been used as "radium" values in this report. Values for radium-228 have been used and designated separately.

Uranium analyses done by extraction or direct fluorometry on untreated samples yielded results similar to analyses done on filtered samples acidified with nitric acid in the field. Duplicate samples were collected at nine sites for direct comparison (CA4, NV6A, NV6B, NV14, NV18, NV33, UT10, UT18, and UT36A). A statistical _t_ test for paired data showed that the two methods of sample treatment yield values that are not significantly different. Therefore, both types of results were used in the data matrix.

Some uranium analyses were done on samples filtered and then acidified with hydrochloric acid. The results are similar to the other uranium values for this study, as indicated by samples from two sites. At Wilson Health Springs (UT18), an untreated sample, a filtered sample acidified with nitric acid, and a filtered sample acidified with hydrochloric acid had 0.13, 0.09, and 0.17 μg/L uranium, respectively. At Baker Hot Springs (UT23), an untreated sample and a filtered sample acidified with hydrochloric acid had 0.05 and 0.15 μg/L, respectively. These results were considered comparable for our purposes, but they suggest that at very low concentrations some of the filtered-acidified samples may have yielded higher uranium values than the untreated samples.

Samples collected at the same sites on different dates separated by a year or more yielded comparable analytical results for radium, uranium, and radon. Pairs of values for radium at six sites (CO14, CO15, CO17, UT9A, UT36A, and UT41), for uranium at seven sites (CO14, CO15, CO17, NV18, UT9A, UT36A, and UT41), and for radon at nine sites (CO10, CO12A, CO12B, CO22, NV18, UT9A, UT18, UT19, and UT23) were used for comparison. Statistical _t_ tests for paired data showed that there is no significant effect on the radium, uranium, or radon values due to the difference in date of sampling, probably because the relatively deep circulation systems keep discharge fluctuations to a miniumum. Therefore, the use of data for samples collected on different dates over a period of several years is considered valid for statistical purposes.

Samples analyzed for radium and uranium by the Environmental Protection Agency, as reported in O'Connell and Kaufmann (1976) and Barrett and Pearl (1976), yielded results similar to ours for the 22 sites we both sampled (AZ17, AZ18, CA4, CO2, CO3, CO17, CO19, CO21, CO25, NV9, NV18, NM1, NM5, UT5B,

UT9A, UT10, UT11, UT12, UT14, UT23, UT41, and UT44). Likewise, radon measurements done by the Environmental Protection Agency were similar to our measurements for the 7 sites we both tested (CA4, CO17, UT5B, UT9A, UT10, UT23, and UT41). Differences in the date of sampling had no significant effect, as discussed above; therefore, it was possible to evaluate the variation in results that can be attributed to the difference in agencies. Statistical t tests for paired data showed that analyses done by the two agencies are not significantly different. As a result, data obtained by the Environmental Protection Agency were used to supplement our data matrix for a few sites we visited but did not sample.

Eh values were obtained in the field, and although they are susceptible to various problems, they are thought to be qualitative measurements of oxidation-reduction potential adequate for statistical purposes. Many of the measured Eh values are probably higher (more oxidizing) than the true Eh of the water because they reflect surficial oxygen as well as other ions and chemical reactions and, therefore, represent upper limits. Several of the values probably reflect the stability of ferrous-ferric iron reactions or the presence of hydrogen sulfide. In general, the positive Eh values were measured in waters that also contain the most dissolved oxygen. Many negative values were measured in waters carrying dissolved ferrous iron, as noted by iron oxide precipitates forming at the spring orifices; the strongest negative values were measured in waters smelling of hydrogen sulfide.

Measurements for fluoride done in the field by specific-ion electrode compare well with analyses done in the laboratory on collected samples, but measurements for chloride, sodium, and divalent ions (calcium and magnesium) do not compare well. Graphic comparisons and correlation analyses show a good correlation of field and laboratory measurements for chloride and sodium, with correlation coefficients of 0.97 for each element; however, field measurements for chloride tend to be higher than laboratory measurements at values over 10,000 mg/L, and field measurements for sodium tend to be higher than laboratory measurements at values over 1,000 mg/L, so statistical t tests indicate significant differences in results. The differences are probably the result of interference in the electrode measurements by other ions present in the water at these high concentrations. Similarly, the electrode measurements of divalent ions are significantly different from laboratory analyses of calcium and magnesium probably because of the presence of other ions, such as strontium and barium, in substantial amounts. As a result of all these comparisons, field measurements for fluoride at sites where samples were not collected for laboratory analysis were used to supplement the laboratory data in the statistical analyses, but field measurements for the other ions were not used.

Analyses for Al, Fe, and Mn done by SPEC methods compare well with those done by WC methods. Direct comparison of Fe and Mn values was possible at many sites, but direct comparison for Al was possible at only two sites (NV18 and UT18). Statistical t tests for paired data showed that there are no significant differences in either Fe or Mn values due to a difference in analytical methods. Values for Al were difficult to evaluate because detection limits were so high for the SPEC data; however, the general distribution of WC values is similar to the distribution of SPEC values reported for other samples.

Analyses for some elements done by SPEC, AA, and WC methods compare well with those done by the semi-quantitative ICP method used in this study, but analyses for other elements do not compare well. Direct comparison of ICP values with other values was possible at only three sites (NV18, UT18, and UT23) where more than one method of analysis was used on the samples collected. Otherwise, a general comparison of ICP values with the values obtained using other methods was relied upon. Values for Cd, Cr, Co, Cu, Ga, Ge, Pb, Ni, Ag, Sn, V, and Zr determined by the ICP method appear to be too high; therefore, these ICP data are not shown in table 2 and were not used in statistical analysis. However, values for Al, Ba, Be, B, Fe, Li, Mn, Mo, Sr, and Zn seem to be comparable (that is, values determined by SPEC or AA methods generally fall within the range of plus or minus two steps from the reported ICP value, where steps are 1, 3, 5, 7, 10, and so on). These ICP data are shown in table 2 and were used in statistical analysis. One element, Ti, showed consistently low ICP values relative to the SPEC data, but because some of the SPEC data were doubtfully high, it was difficult to evaluate either the ICP data or the SPEC data. Therefore, Ti values are not shown and were not used in the statistical analysis.

Data processing

For statistical purposes, data from samples collected at different times or analyzed by different methods had to be combined to obtain one complete set of values for a given site. Where parameter values for one sample from a given site complemented parameter values for another sample from the same site, combination of data was relatively straightforward. Where parameter values for one sample were obtained by more than one method of analysis or were duplicated by parameter values for another sample, selection of data was more complex and subjective. The net result of this stage of data processing was a data matrix composed of one row for each sample site and one column for each parameter.

Most duplicate analyses are similar, as discussed previously, so to some extent it didn't matter which values were selected. Selection had to be done, however, and certain biases were used. In general, measurements from this study were favored over published analyses, which were used only to fill gaps in the data. Field measurements were chosen over laboratory measurements for pH and specific conductance because field data are thought to better reflect the actual environment. For precision, the SPEC, AA, or WC data were preferred over the ICP data, and the AA data were preferred over the SPEC data. In general, SPEC data were used over WC data, but where lower limits of detection were very high in the SPEC data, the WC data were used in order to minimize the number of "less than" values.

Data recorded as greater than an upper reporting limit or less than a lower limit of detection are known as qualified values. Such data cannot be used directly in many statistical programs; they have to be omitted, or they have to be assigned arbitrary values. Water data are particularly troublesome because, although detection limits for trace elements analyzed by AA, ICP, or WC methods are constant, detection limits for elements analyzed by SPEC methods vary with the total dissolved solids content due to interference by other elements.

For this study, an effort was made to maximize the use of the data and still achieve a valid statistical analysis. Where less than 30 percent of the data for a given element in this study were below a variable detection limit or where less than 50 percent of the data were below a constant detection limit, arbitrary values were chosen to replace the qualified values. Where more than 30 percent of the data were below a variable detection limit or where more than 50 percent of the data were below a constant detection limit, the qualified values were not used. Arbitrary values for "less than" values were chosen at one-fourth the lower limit of detection, to the nearest one significant digit; arbitrary values for "greater than" values were chosen at two times the upper reporting limit, to the nearest one significant digit.

Most statistical procedures assume normal distributions for the variables used; therefore, data which best approximate a normal distribution for each parameter were needed in the statistical analysis. Distributions for all parameter values except pH and Eh were found to be generally log normal; therefore, arithmetic values were used for pH and Eh in the statistical analysis, and logarithmic values were used for all other parameters.

Statistical analysis

Relationships among the various measured parameters were investigated by doing correlation and factor analysis and by inspecting scatter diagrams. Linear correlation analysis was used to evaluate pairs of covarying parameters using a data matrix of all samples and parameters. Linear correlation analysis followed by R-mode factor analysis was used to delineate groups of covarying parameters using a data matrix of selected samples and parameters. Scatter diagrams were used to note the pattern and spread of data points and to evaluate the effects of extreme values on the correlation coefficients.

Correlation analysis was first done using all samples and parameters, even though not all samples had been measured for every parameter. Because of the gaps in the data matrix, the number of valid pairs of data, as well as the value defining which coefficients are significant, was different for nearly every correlation coefficient determined. The resultant nonsymmetric matrix of correlation coefficients, used in conjunction with scatter diagrams, provided a means of evaluating relationships among all the measured parameters.

Another correlation analysis was done using selected samples and parameters as a prerequisite for R-mode factor analysis. Samples and parameters were selected to obtain a data set with values for every parameter. Therefore, the number of valid pairs of data, as well as the value defining which coefficients are significant, was the same for each correlation coefficient. The resultant symmetric matrix of correlation coefficients was used as input for the factor analysis. The factor analysis was used to define groups of covarying parameters.

The methods of statistical analysis used in this report provided an objective means of delineating parameter groups, which in turn provided a basis for interpreting some of the principles and processes controlling the composition of natural water in the systems studied.

Data presentation

Chemical analyses and other parameters measured on water from the 156 sites where water samples were collected are listed in table 2. Samples from more than one spring were collected at seven sites, making a total of 163 analyses. Data from samples collected on different dates, data from samples analyzed by different methods, and data taken from published reports are designated in the footnotes.

Radioactivity

Radium, uranium, and radon are the radioactive elements measured in the mineral-spring waters. Helium, although not radioactive, is a product of radioactive decay and was also measured. All 163 samples have data for radium and uranium. Twenty samples were analyzed for radium-228. Data for radon-222 is available for 96 samples. Helium was measured in 35 samples.

The radioactive elements have a wide range of values, as summarized in table 3 and shown on figures 3-7. Radium ranges from less than 0.1 to 300 pCi/L and has a geometric mean of 1.48 pCi/L. Uranium ranges from less than 0.01 to 120 μg/L and has a geometric mean of 0.26 μg/L. Radon ranges from less than 10 to 110,000 pCi/L and has a geometric mean of 549 pCi/L. Helium ranges from -1,300 to + 13,000 ppb (parts per billion) relative to atmospheric helium (5,240 ppb) and has a geometric mean of + 725 ppb. Radium-228 ranges from less than 2.0 to 33 pCi/L; because of the large number of values below the detection limit, a mean value was not calculated.

Anomaly thresholds for the radioactive elements were defined as being two geometric deviations above the geometric mean. Threshold values determined in this way are as follows: radium, 170 pCi/L; uranium, 48 μg/l; radon, 20,000 pCi/L; and helium, 10,000 ppb. Accordingly, 10 sample sites (fig. 8) have anomalously radioactive water. Radium is anomalous in Soda Dam Hot Springs (NM1) and in Crystal Springs (UT5B). Uranium is anomalous in Yellow Soda Spring (CO14), in the spring in Nye Canyon (NV28), and in Wildhorse Spring (UT19). Both radium and uranium are anomalous in Taylor Soda Spring (CO15). Radon is anomalous in Alhambra hot springs and warm well (MT3 and MT4) and in Grant View hot springs (NV29). Helium is anomalous only in Utah Hot Springs (UT10).

Ratios of radium to uranium and visa versa, as well as radium and uranium to specific conductance, also provided a means of evaluating sites for anomalous radioactivity. The radium to uranium ratio multiplied by 2.95 gives a measure of radium enrichment above equilibrium with uranium in the water and is designated by REF (radium enrichment factor) in table 2. Likewise, the uranium to radium ratio multiplied by 0.339 is designated by UEF (uranium enrichment factor). The ratios of radium or uranium to specific conductance give a measure of radioactive element abundance normalized by the total abundance of all other dissolved constituents. Anomaly threshold values for each of these ratios are as follows: REF, 22,000; UEF, 78; Ra/spc, 28; U/spc, 37. Accordingly, four additional sites have anomalous radioactivity, as shown on figure 8. Stinking Hot Springs (UT9A) has an anomalous REF; and Monte Neva Hot Springs (NV18), Faywood Hot Springs (NM5), and Washakie Mineral Hot Springs (WY8) have anomalous Ra/spc. Three of the sites having anomalous element values also have anomalous ratios. Soda Dam Hot Springs (NM1) has anomalous Ra/spc as well as anomalous radium, and the Alhambra warm well (MT4) has anomalous Ra/spc as well as anomalous radon. The spring in Nye Canyon (NV28) has anomalous UEF and U/spc as well as anomalous uranium.

Several of these anomalously radioactive sites are in or near areas of known uranium occurrences. Taylor Soda Spring (CO15) and Yellow Soda Spring (CO14) are north of the Tallahassee Creek uranium mining district (Heinrich and Bever, 1957; Epis and others, 1979); they issue from Tertiary alluvium overlying Precambrian quartz monzonite in an area of abundant Tertiary volcanic rocks. Uranium deposits in the area are in paleochannels in the alluvium. Alhambra Hot Springs and warm well (MT3 and MT4) are just east of uranium occurrences near Clancy (Roberts and Gude, 1953; Leonard and Janzer, 1977); they issue from fractured Cretaceous to Tertiary quartz monzonite and alaskite. Uranium occurrences in the area are in siliceous veins in the granitic rocks. Wildhorse Spring (UT19) is in the Spor Mountain mining district in the Thomas Range (Staatz and Carr, 1964; Lindsey, 1979); it issues from Tertiary rhyolitic volcanic rocks. Uranium deposits in the area are in volcanic tuff, in breccia pipes in adjacent Paleozoic sedimentary rocks, and in nearby Tertiary beryllium-tuff beds. Grant View hot springs (NV29) are in the East Walker River area near Coal Valley (Staatz and Bauer, 1953; Nowak, 1979); they issue from fractured Mesozoic quartz monzonite. Uranium occurrences in the area are in quartz veins in the granitic rocks and also in Tertiary sedimentary rocks in fault contact with the granitic rocks. Soda Dam Hot Springs (NM1) are in the southwest part of the Jemez Mountains; they issue from Precambrian metamorphic rocks overlain by Paleozoic sedimentary rocks in an area of abundant Tertiary and Quaternary volcanic and associated sedimentary rocks (Dane and Bachman, 1965). Uranium occurs in the volcanic rocks in the area.

The association of anomalous radioactivity in mineral-spring water with areas of known uranium occurrences suggests that the other springs with anomalous radioactivity may be associated with unknown uranium occurrences. Monte Neva Hot Springs (NV18) are in Steptoe Valley near the Egan Range; they issue from valley alluvium near a faulted complex of Precambrian and Paleozoic sedimentary rocks overlain by Tertiary volcanic rocks and intruded by Tertiary granitic rocks (Stewart and Carlson, 1974). The spring in Nye Canyon (NV28) is in the Pine Grove Hills; it issues from Tertiary siliceous volcanic rocks near a contact with Cretaceous granitic rocks (Carlson and others, 1978). Crystal Springs (UT5B), Stinking Hot Springs (UT9A), and Utah Hot Springs (UT10) are on the northeast side of the Great Salt Lake basin near the Wasatch Range; they issue along north-trending faults parallel to the range front near Precambrian and Paleozoic faulted sedimentary and metamorphic rocks (Bjorklund and McGreevy, 1974; Sorensen and Crittenden, 1972). Washakie Mineral Hot

Springs (WY8) are in the Wind River basin; they issue from valley alluvium overlying fractured Pennsylvanian sandstone in the crest of an anticline of Paleozoic and Mesozoic sedimentary rocks (Whitcomb and Lowry, 1968). Faywood Hot Springs (NM5) are in the Mimbres River basin south of the Cobre Mountains; they issue from valley alluvium near Pennsylvanian carbonate rocks and Tertiary and Quaternary volcanic rocks (Dane and Bachman, 1965).

Notably, most of the anomalies in spring water near known uranium occurrences are for uranium and radon and are in granitic or volcanic terranes. Radon is anomalous in the springs issuing directly from fractured granitic rocks (MT3, MT4, and NV29); uranium is anomalous in springs issuing from granitic or volcanic rocks with relatively thin alluvial cover (CO14, CO15, and UT19). In contrast, most of the anomalies in spring water in areas with no known uranium occurrences are for radium or Ra/spc and are in varied sedimentary, igneous, and metamorphic terranes. Ra/spc is anomalous in springs issuing from relatively thick alluvial fill some distance from nearby mountains composed at least in part of sedimentary rocks (NV18, NM5, and WY8); radium and REF are anomalous in springs near metamorphic and sedimentary rocks (UT9A and UT5B).

The contrast in type of anomaly between areas with known uranium occurrences and areas with no known occurrences may be related as much to a difference in geologic terrane as to the presence or absence of uranium deposits. Therefore, it is possible that certain types of anomalies are characteristic of certain terranes and may not be indicative of uranium occurrences. However, two of the springs studied in areas of known occurences have more than one type of anomaly, and one spring has only radium anomalies. Taylor Soda Spring (CO15) has anomalous radium as well as uranium, and the Alhambra warm well (MT4) has anomalous Ra/spc as well as radon. Soda Dam Hot Spring (NM1) has anomalous radium and Ra/spc. Therefore, anomalous radium or Ra/spc may, indeed, be indicative of uranium occurrences. The type of anomaly is apparently influenced by the geologic environment, the characteristics of the hydrologic system, and the presence of alluvial fill, as well as the presence of uranium-rich rocks. The influence of the hydrologic system and the associated geochemical environment is discussed in the following sections of this report.

Other geochemical characteristics

Major-ion chemistry of the sampled waters is summarized in table 4, and a graphic summary is given on the diagram in figure 9. The scatter of points in the diagram shows that nearly all types of water are represented. (See Hem, 1970, p. 264-270, or Hall, 1963, p. 163-164, for disscussion of water classification.) Sodium chloride and sodium bicarbonate waters are most abundant, comprising about 50 percent of the 124 samples analyzed for major ions. Calcium bicarbonate, sodium sulfate, and calcium sulfate waters constitute about 20 percent of the samples. Various other types of water composed of more than one significant cation or anion make up the remaining 30 percent of the samples.

Minor-element chemistry is also summarized in table 4. The wide range of values for nearly all the parameters indicates that a variety of springs was sampled. Some springs are particularly noteworthy in their extreme values. Sample CO12B had the lowest pH and bicarbonate and the highest Fe, Al, Cu, Ni, and Y; it is from a group of springs discussed in an earlier report by Cadigan, Felmlee, and Rosholt (1976). Sample UT19 had the highest Hg; it also had a very high U content and is from the Spor Mountain mining district. Sample UT18 had the highest Yb and the only recorded Nd content; it is from a group of springs near the Fish Springs Range, about 20 km from Spor Mountain. Sample AZ16 had the highest Mo and Zn; sample NV9 had the highest Cr, Co, and Pb.

Results of statistical analysis

Correlation analysis

A correlation analysis using all samples and parameters was made on the data. The matrix of linear correlation coefficients and corresponding numbers of valid data pairs is shown in table 5. Correlations were evaluated as significant at the 95-percent level for the number of valid data pairs. The correlation coefficients in table 5 were then used in selecting parameters for factor analysis.

Significant correlation coefficients involving parameters having truncated distributions were additionally evaluated by scatter diagrams. Reported values were plotted to test for the effects of extreme values. As a result, the significant correlation coefficients for nickel and silica, for silver and specific conductance, and for gallium and radium or calcium were found to be invalid.

Factor analysis

R-mode factor analysis was done to elucidate relationships among the measured parameters by objectively analyzing the variance in a correlation matrix based on those parameters. In order to do this, certain requirements had to be met. First, a symmetric matrix of correlation coefficients had to be obtained by selecting samples and parameters such that all selected samples had data for all selected parameters. This selection process is discussed below. Second, unintentional weighting of the results had to be eliminated by omitting parameters strongly related to other parameters, as shown by correlation coefficients greater than 0.95 (table 5). By this process, parameters such as total dissolved solids, alkalinity, and hardness were eliminated because of their close relationships with specific conductance, bicarbonate, and calcium and magnesium concentrations, respectively.

A data matrix of 71 samples and 24 parameters was finally selected for correlation and factor analysis. The matrix of correlation coefficients for 24 parameters using 71 samples is shown in table 6. A comparison of these correlation coefficients with those for the same parameters using all samples (table 5) reveals a few differences in relative magnitude of the coefficients, such as the coefficient for pH and HCO3+CO3, but the differences do not alter the results of the factor analysis, as discussed below.

The parameters chosen for correlation and factor analysis included Eh, radium, uranium, most of the major ions, and many of the trace elements. In order to include Eh, many samples had to be omitted. This was done because the presence of Eh in the factor analysis significantly enhanced the interpretation of factors and parameter relationships. Also, the use of fewer samples did not significantly alter the major parameter relationships. This was determined by a trial factor analysis which did not include Eh.

Trial factor analyses were done on other selected data sets to get a more complete picture of parameter relationships, but the results of these analyses were not significantly different from the factor analysis based on the data matrix of 71 samples and 24 parameters. One correlation and factor analysis included 120 samples by using only 23 parameters, omitting Eh. The parameter groups remained almost unchanged; only manganese shifted position. Another correlation and factor analysis included radon by using a data matrix of 25 parameters and the same 71 samples. None of the parameter groups changed, and the low communality shown by radon indicated that none of the major factors accounted for a substantial amount of the variation in radon values.

Evaluation of the R-mode factor analysis of the correlation matrix shown in table 6 resulted in selection of the first three factors as the major causes of variation among the 24 parameters. The reordered varimax factor matrix for the third rotation is shown in table 7. Five rotations had eigenvalues greater than 1, but the third rotation was chosen as the best for interpretation because the fourth rotation contained a factor group with only one parameter in it. The three factors account for 70 percent of the total variance. They represent major controls on water composition in the hydrogeologic environments of the spring systems and have been interpreted as follows: (1) duration of water circulation, (2) depth of water circulation, and (3) partial pressure of carbon dioxide.

Factor 1, duration of water circulation, is strongly related to the salinity of the water. Concentrations of many elements tend to get higher the longer the water is in contact with the rocks in the hydrogeologic system. This phenomenon produces saline water, which has high specific conductance and high total dissolved solids. Element concentrations are also affected by porosity and permeability of the rocks in the system, by the water-rock ratio, and by the rock composition, but the duration of circulation is thought to be the dominant overall influence. Very little data is available on actual ages of circulating water, but tritium and radiocarbon ages for spring systems in Nevada, for example, indicate that older waters often have higher concentrations of sodium, potassium, chloride, and sulfate (Mifflin, 1968). Whereas the salinity of some springs, such as Glenwood Springs (CO3), has been attributed to the presence of saline rocks in the system (Bass and Northrop, 1963), the salinity of other springs, such as the Salt Banks springs (AZ16), has been attributed to the "slow passage of the waters" through igneous and metamorphic rocks (Feth, 1954).

Element species in this group include the alkali metals and monovalent anions. These species tend to stay in solution once they are taken into solution. They form chloride, sulfate, or borate salts of high solubility in most near-surface and subsurface environments; therefore, they can attain very high concentrations in the water before they reach the levels necessary for precipitation. Strontium, although an alkaline-earth element, also forms compounds of relatively high solubility and, therefore, tends to stay in solution.

Several elements in the factor 1 group have moderate secondary loadings on other factors. Iron and manganese, which have only moderate loadings on factor 1, have only slightly lower positive loadings on factor 3, partial pressure of carbon dioxide. Both of these elements form oxides and hydroxides that are relatively insoluble in the near-surface environment. An increase in partial pressure of carbon dioxide lowers the pH, increases the solubility of these oxides, and causes more iron and manganese to go into solution.

Strontium, like iron and manganese, also has a moderate positive secondary loading on factor 3. As an alkaline-earth element, strontium has a geochemical behavior similar to that of the other alkaline-earth elements, which constitute the cations in the factor 3 group. Solubilities of strontium sulfate and carbonate minerals are high enough to permit large concentrations of dissolved strontium to accumulate in many spring waters as the partial pressure of carbon dioxide increases.

Specific conductance and potassium also have moderate positive secondary loadings on factor 3. Specific conductance, like pH, depends on the type and amount of ions in the water. Water that has a high conductance and high concentrations of alkali metals also tends to have high concentrations of alkaline-earth metals and a moderately low pH.

Lithium, boron, molybdenum, and manganese have moderate positive secondary loadings on factor 2, depth of circulation. In this study these elements tend to have high concentrations in water of high temperature as well as high salinity.

Factor 2, depth of water circulation, is strongly related to temperature. Numerous investigators have attributed high temperatures of surface springs to deep circulation. The deeper the water circulates the hotter it becomes because of the geothermal gradient in the Earth's crust. Water temperatures observed at the surface are affected by how rapidly the water rises along conduits and by whether or not mixing with cooler water occurs near the surface, but the maxium temperature attained by the water is caused by contact with rocks at depth that are heated by conductive heat flow from within the Earth. Further discussions of temperature-depth relationships, estimation of deep reservoir temperatures from measured surface spring temperatures, and exploration of modern geothermal systems can be found in Mifflin (1968), Fournier, White, and Truesdell (1974), and Ellis (1970, 1979).

Element species with positive loadings in factor 2 are fluoride and aqueous silica. The solubilities of fluorite and silica polymorphs are known to be directly related to temperature, at least in the low ranges applicable to this study (0-150°C for fluorite; 0-300°C for silica) (Holland and Malinin, 1979). The solubilities of the silica polymorphs are virtually independent of salinity and pH because dissolved silica is uncharged. The solubility of fluorite, although responsive to changes in salinity and pH because of the ionic form of dissolved calcium and fluoride, is only slightly affected by salinity and is insensitive to pH over the pH and salinity ranges found in this study (Holland and Malinin, 1979).

Several parameters in the factor 2 group have negative loadings. These parameters tend to decrease in concentration with increasing temperature. Eh, a measure of oxidation-reduction potential, is negative to temperature because high-temperature water generally circulates deeply and does not carry as much dissolved oxygen as shallower circulating low-temperature water; any oxygen that may have been taken into solution at shallow depths is likely to react at higher temperatures and be lost to the surrounding rocks during wall-rock alteration. Aluminum tends to be lower in high-temperature, high-silica water because it is used in the formation of clay minerals during wall-rock alteration at depth. Uranium is probably lower in high-temperature water because deeply circulating water commonly has a relatively low Eh, and uranium forms minerals that are insoluble in a reducing environment; alternatively, low-temperature water commonly has a relatively high Eh, and uranium forms bicarbonate and phosphate complexes that are soluble in an oxidizing environment. Nitrite and nitrate are probably lower in high-temperature water because deeply circulating water is less likely to contain organic species that may be present as contaminants in low-temperature shallow-circulating water.

Some parameters in the factor 2 group have moderate secondary loadings on factor 1, duration of circulation. The concentration of fluoride tends to increase as salinity increases because the solubility of fluorite, as mentioned above, is affected by salinity as well as temperature. Aluminum, also, has higher concentrations in more saline water, probably because of the formation of aqueous complexes. Temperature is positively related to duration of circulation and Eh is negatively related because deeper circulating, hotter water is usually in contact with the rocks in the system longer than shallower circulating water containing dissolved atmospheric oxygen.

Factor 3, partial pressure of carbon dioxide, is strongly related to concentrations of species involved with carbonate equilibria. As carbon dioxide from the atmosphere and from the rocks in the hydrogeologic system becomes dissolved in the water, calcium and magnesium also go into solution. Barium and radium, as alkaline-earth elements, apparently behave similarly to calcium and magnesium, and the sulfate content of the water generally remains low enough that the concentrations of these elements are not controlled by barite solubility in most of the springs sampled.

This factor group contains the bicarbonate and carbonate ions and the alkaline-earth elements, but it also contains pH, which has a negative loading on this factor. As more carbon dioxide becomes dissolved in the water, the pH decreases. Therefore, spring waters containing abundant carbon dioxide, as noted by vigorous bubbling and travertine deposition, tend to have a relatively low pH. As the waters flow away from the orifice and lose carbon dioxide during travertine deposition, the pH rises, as noted by measurements over about 100 m of flow at one tested spring (NV18). Although we did not test the gases released, other studies (for example, Scott and Barker, 1962) indicate that carbon dioxide is the most common and abundant gas in many travertine-depositing systems.

Most ions in the factor 3 group show moderate secondary loadings on other factors. Calcium and magnesium have negative loadings on factor 2, depth of circulation. This relationship is consistent with carbonate equilibria. Because the carbonate mineral solubilities are known to decrease with increasing temperature, the concentrations of calcium and magnesium tend to be higher in lower temperature, shallower circulating water than in higher temperature, deeper circulating water. Calcium, radium, and bicarbonate all have positive loadings on factor 1, duration of circulation. This relationship also reflects carbonate equilibria. The solubilities of minerals such as calcite increase with increasing salinity, or total ionic strength, of the water; therefore, the concentrations of calcium and bicarbonate tend to be greater in more saline water. Radium apparently shows a geochemical behavior similar to calcium because of its alkaline-earth identity.

The matrix of correlation coefficients shown in table 5 was used to subjectively evaluate relationships between the factor parameter groups and the parameters not used in the factor analysis. Most of the parameters not used in the factor analysis have significant positive correlations with the parameters in factor 1. Cobalt, copper, zinc, yttrium, and ytterbium correlate with numerous elements in factor 1, and chromium, rubidium, scandium, and phosphate correlate with several elements in factor 1. Germanium correlates with phosphate. Selenium correlates with sulfate. Beryllium correlates with several elements in factor 1 but also shows a positive correlation with uranium in factor 2. Concentrations of all these elements tend to increase with increasing salinity. These elements are present in very small amounts because they are associated with minerals that are relatively insoluble in most near-surface environments but whose solubilities are increased by the presence of saline solutions and the formation of aqueous complexes.

Several parameters not used in the factor analysis have significant correlations with parameters in factor 2. Dissolved oxygen correlates with Eh, uranium, and nitrate-nitrite and is negative with temperature, fluoride, and silica; like Eh, it has negative correlations with several elements in factor 1. Arsenic has positive correlations with temperature, fluoride, and silica and negative correlations with Eh and nitrate-nitrite. Helium has a positive correlation with temperature and negative correlations with uranium and dissolved oxygen. Radon correlates with temperature, silica, fluoride, and arsenic but also with radium in factor 3. Lead is positive with temperature, silica, fluoride, arsenic, and radon and is negative with Eh and uranium. Concentrations of these elements are apparently affected by variations in temperature and oxidation-reduction potential. The correlations shown by dissolved oxygen are particularly noteworthy and indicate that the abundance of dissolved oxygen is a very important influence on Eh measurements, as expected. Radon and helium are both gases, and their relative abundance in hot water may reflect increased solubility in water which has circulated deeply and been under increased pressure.

Only one of the omitted parameters has a significant correlation with parameters in factor 3. Radium-228 has a positive correlation with radium (primarily radium-226), as might be expected for isotopes of the same element. Three other omitted elements--silver, nickel, and gallium--have significant correlations with parameters in one of the factor groups, but scatter diagrams indicated that these correlations are unduly influenced by extreme values.

Factor scores were computed in order to evaluate the influence of the identified factors on each sample used in the factor analysis. Because uranium mineralization was not one of the identified factors, factor scores do not provide direct information on the relationship between particular springs and possible mineralization; however, factor scores do quantify the influence of the identified hydrogeologic environmental factors on individual springs, and this information can then be used in conjunction with anomalous radioactivity data in evaluating the springs.

Factor scores were determined by multiplying the data matrix by the varimax factor matrix. The results are shown in standardized form (table 8); a zero in the column indicates an average influence of that factor on the sample, a high positive score indicates a high intensity of that factor, and a high negative score indicates a low intensity. Positive scores on factor 1 indicate relatively old waters, positive scores on factor 2 indicate relatively deep waters, and positive scores on factor 3 indicate relatively carbonated waters.

The samples show every combination of positive and negative factor scores for the three factors. The distribution of positive and negative scores for each sample indicates that most of the samples fall into two broad categories of water, as shown by positive or negative scores on factors 1 and 2 (table 8): (1) older, deeper circulating water, and (2) younger, shallower circulating water. The first type of water is characterized by relatively high salinity, high temperature, and low Eh, and the second type is characterized by relatively low salinity, low temperature, and high Eh. Either type can be influenced by partial pressure of carbon dioxide, resulting in a relatively low or high pH, as shown by the positive or negative scores on factor 3. The rest of the samples fall into two other groups--nominally, older, shallower circulating water and younger, deeper circulating water--as shown by positive scores on factor 1 and negative scores on factor 2, or visa versa. These waters are characterized by relatively high salinity, low temperature, and high Eh or by relatively low salinity, high temperature, and low Eh. Again, either type can be influenced by relatively high or low partial pressure of carbon dioxide.

The common occurrence of the first two types of water--older, deeper water and younger, shallower water--is consistent with current concepts of water circulation in most hydrogeologic systems. The occurrence of the last two types of water--older, shallower water and younger, deeper water--testifies to the complexity of some hydrogeologic systems. Salinity generally increases with time, but high salinity can be attained in less time if the rocks contain abundant salts of high solubility or if the rocks have a porous and permeable texture allowing maximum contact of water with the surface area of the mineral grains. Temperature normally increases with depth, but high temperatures can be acquired at a relatively shallow depth if the geothermal gradient is abnormally high due to the presence of a magma body at shallow depth. High temperatures acquired at depth are best preserved by rapid rise of the water to the surface along fault systems; however, heat can be lost by a slow rise to the surface or by mixing with cooler water. These variations in the hydrogeologic systems can result in saline waters of abnormally low temperature, cool waters of abnormally high salinity, fresh waters of abnormally high temperature, and hot waters of abnormally low salinity. Waters designated "older, shallower" or "younger, deeper" may, therefore, be "older, deeper" or "younger, shallower" waters from complex systems showing abnormally high or low temperature or salinity.

Uranium or radium concentrations can be high in any of the identified types of water, and the variance in uranium and radium values is another indication of the complexity of some hydrogeologic systems. The three identified factors (table 7) account for 60 percent of the variance in uranium values and 71 percent of the variance in radium values, as shown by the communality. The remaining 30 to 40 percent of the variance is unexplained. Uranium concentrations tend to be higher in waters of relatively low temperature and high Eh, and radium concentrations tend to be higher in waters having relatively high amounts of dissolved carbonate species (low pH) and, secondarily, relatively high salinity. Thus, radium and uranium concentrations vary with the three identified factors, but they also vary with unidentified factors such as the composition of common rocks in the systems. Radium and uranium concentrations can be abnormally high in the vicinity of uranium-rich rocks.

The occurrence of anomalous radioactivity in the springs may still be the best indicator of uranium-rich rocks, whether they are in simple or complex hydrogeologic systems. Some of the samples having anomalous radioactive-element concentrations occur in the first two categories of water shown in table 8 (MT4, NV28, NV29, UT9A, UT10); these samples may reflect variations in relatively simple hydrogeologic systems. Alhambra warm well (MT4) and Grant View hot springs (NV29), as discussed earlier, are in areas of known uranium occurrences in fractured granitic rocks. Other samples having anomalous radioactive-element concentrations occur in the other categories (CO14, CO15, NV18, and UT19); these samples may reflect variations in more complex systems and may, therefore, be particularly good indicators of uranium-rich rocks in more varied geologic terranes. As discussed earlier, Wildhorse Spring (UT19) is in the Spor Mountain mining district, and Yellow Soda Spring (CO14) and Taylor Soda Spring (CO15) are near the Tallahassee Creek uranium district. These springs are not known to be directly associated with particular deposits, but their identification here as anamously radioactive complex spring systems makes a direct association feasible. Monte Neva Hot Springs (NV18), also discussed earlier, is not known to be associated with nearby uranium occurrences, but its identification with this group of springs make it of primary interest for uranium exploration.

Conclusion

Multivariate statistical analyses indicate that three major factors affect water composition in the spring systems studied: (1) duration of water circulation, (2) depth of water circulation, and (3) partial pressure of carbon dioxide. An examination of factor scores indicates that several types of hydrogeologic systems were sampled. Most of the samples are from simple hydrogeologic systems involving (1) older, deeper circulating water having relatively high salinity, high temperature, and low Eh or (2) younger, shallower circulating water having relatively low salinity, low temperature, and high Eh. The rest of the samples are probably from complex hydrogeologic systems involving older, deeper water or younger, shallower water having abnormally high or low salinity or temperature. Any of the systems can have a relatively high or low content of dissolved carbonate species, resulting in a low or high pH, respectively. Uranium concentrations are commonly higher in waters of relatively low temperature and high Eh, and radium concentrations are commonly higher in waters having a relatively high carbonate content (low pH) and, secondarily, relatively high salinity.

The statistical variance in radium and uranium concentrations unaccounted for by the identified factors also testifies to the complexity of some hydrogeologic systems. Unidentified factors related to geologic setting and the presence of uranium-rich rocks in the systems also affect the observed concentrations of the radioactive elements in the water. The association of anomalous radioactivity in several springs with nearby known uranium occurrences indicates that other springs having anomalous radioactivity may also be associated with uranium occurrences as yet undiscovered. Anomalously radioactive springs associated with known occurrences are Taylor Soda Spring

(C015) and Yellow Soda Spring (C014); Alhambra Hot Springs (MT3) and warm well (MT4); Wildhorse Spring (UT19); Grant View Hot Springs (NV29); and Soda Dam Hot Springs (NM1). Springs having anomalous radioactivity but not associated with known occurrences are Monte Neva Hot Springs (NV18); the spring in Nye Canyon (NV28); Crystal Springs (UT5B), Stinking Hot Springs (UT9A), and Utah Hot Springs (UT10); Washakie Mineral Hot Springs (WY8); and Faywood Hot Springs (NM5).

References

Baker, C. H., Jr., 1968, Thermal springs near Midway, Utah, in Geological Survey research 1968: U.S. Geol. Survey Prof. Paper 600-D, p. 63-70.

Barrett, J. K., and Pearl, R. H., 1976, Hydrogeological data of thermal springs and wells in Colorado: Colorado Geol. Survey Inf. Series 6, 124 p.

Bass, N. W., and Northrop, S. A., 1963, Geology of Glenwood Springs quadrangle and vicinity, northwestern Colorado: U.S. Geol. Survey Bull. 1142-J, 74 p.

Bjorklund, L. J., and McGreevy, L. J., 1974, Gound-water resources of the lower Bear River drainage basin, Box Elder County, Utah: Utah Dept. Natural Resources Tech. Pub. 44, 65 p.

Boltwood, B. B., 1905, On the radioactive properties of the waters of the springs on the Hot Springs Reservation, Hot Springs, Arkansas: Am. Jour. Science, 4th Ser., v. 20, p. 128-132.

Cadigan, R. A., Felmlee, J. K., and Rosholt, J. N., 1976, Radioactive mineral springs in Delta County, Colorado: U.S. Geol. Survey Open-File Rept. 76-223, 39 p.

Carlson, J. E., Stewart, J. H., Johannesen, Dann, and Kleinhampl, F. J., 1978, Preliminary geologic map of the Walker Lake 1^0 by 2^0 quadrangle: U.S. Geol. Survey Open-File Rept. 78-523, 1 sheet.

Chadwick, R. A., and Kaczmarek, M. B., 1975, Geothermal investigations of selected Montana hot springs, in Energy resources of Montana: Montana Geol. Survey 22d Ann. Pub., p. 209-216.

Dane, C. H., and Bachman, G. O., 1965, Geologic map of New Mexico: U.S. Geol. Survey, scale 1:500,000, 2 sheets.

Ellis, A. J., 1970, Quantitative interpretation of chemical characteristics of hydrothermal systems: Geothermics, Spec. Issue 2, p. 516-528.

______1979, Explored geothermal systems, in Barnes, H. L., ed., Geochemistry of hydrothermal ore deposits, Second edition: New York, John Wiley and Sons, p. 632-683.

Epis, R. C., Wobus, R. A., and Scott, G. R., 1979, Preliminary geologic map of the Black Mountain quadrangle, Fremont and Park Counties, Colorado: U.S. Geol. Survey Open-File Rept. 79-652, 12 p.

Feth, J. H., 1954, Preliminary report of investigations of springs in the Mogollon Rim region, Arizona, with sections on Base flow of streams, by N. D. White, and Quality of water, by J. D. Hem: U.S. Geol. Survey Open-File Rept., 77 p.

Feth, J. H., and Barnes, Ivan, 1979, Spring-deposited travertine in eleven Western States: U.S. Geol. Survey Water-Resources Inv. Open-File Rept. 79-35, 1 sheet.

Fournier, R. O., White, D. E., and Truesdell, A. H., 1974, Geothermal indicators of subsurface temperature--Part 1, Basic assumptions: Jour. Research U.S. Geol. Survey, v. 2, no. 3, p. 259-262.

Gary, Margaret, McAfee, Robert, Jr., and Wolf, Carol, eds., 1974, Glossary of geology, with a forward by Ian Campbell: Falls Church, VA, Am. Geol. Inst., 805 p.

Hall, F. R., 1963, Springs in the vicinity of Socorro, New Mexico: New Mexico Geol. Soc. Guidebook, 14th Field Conf., Socorro Region, p. 160-179.

Heinrich, E. W., and Bever, J. E., 1957, Radioactive mineral occurrences in the Guffey area, Park and Fremont Counties, Colorado: Colorado School Mines Quart., v. 52, no. 4, p. 23-35.

Hem, J. D., 1970, Study and interpretation of the chemical characteristics of natural water: U.S. Geol. Survey Water-Supply Paper 1473, 363 p.

Holland, H. D., and Malinin, S. D., 1979, The solubility and occurrence of non-ore minerals, _in_ Barnes, H. L., ed., Geochemistry of hydrothermal ore deposits, Second edition: New York, John Wiley and Sons, p. 461-508.

Leonard, R. B., and Janzer, V. J., 1977, Natural radioactivity in geothermal waters, Alhambra Hot Springs and nearby areas, Jefferson County, Montana: U.S. Geol. Survey Open-File Rept. 77-624, 20 p.; U.S. Geol. Survey Jour. Research, 1978, v. 6, no. 4, p. 529-540.

Lindsey, D. A., 1979, Tertiary volcanism and uranium mineralization in the Thomas Range and northern Drum Mountains, Juab County, Utah: U.S. Geol. Survey Open-File Rept. 79-1976, 141 p.

Mallory, E. C., Jr., and Barnett, P. R., 1973, Chemical and spectrochemical analyses of selected ground water in Colorado: U.S. Geol. Survey Open-File Rept., 47 p.

Mariner, R. H., Presser, T. S., and Evans, W. C., 1976, Chemical characteristics of the major thermal springs of Montana: U.S. Geol. Survey Open-File Rept. 76-480, 30 p.

______1977, Chemical, isotopic, and gas compositions of selected thermal springs in Arizona, New Mexico, and Utah: U.S. Geol. Survey Open-File Rept. 77-654, 42 p.

Mifflin, M. D., 1968, Delineation of ground-water flow systems in Nevada: Univ. Nevada, Center for Water Resources Research, Desert Research Inst., Tech. Rept. Ser. H-W, Pub. No. 4, 111 p.

Mundorff, J. C., 1970, Major thermal springs of Utah: Utah Geol. and Mineral. Survey Water Resources Bull. 13, 60 p.

______1971, Nonthermal springs of Utah: Utah Geol. and Mineral. Survey Water Resources Bull. 16, 70 p.

Nowak, Gregory, 1979, The geology and uranium occurrences of the Washington mining district, Lyon County, Nevada: Univ. Nevada, M.S. thesis, 92 p.

O'Connell, M. F., and Kaufmann, R. F., 1976, Radioactivity associated with geothermal waters in the Western United States--Basic Data: Environmental Protection Agency, Office of Radiation Programs, Tech. Note ORP/LV-75-8A, 25 p.

Peterson, J. E., Buell, S. E., Cadigan, R. A., Felmlee, J. K., and Spirakas, C. S., 1977, Uranium, radium, and selected metallic-element analyses of spring water and travertine samples from the Grand Canyon, Arizona: U.S. Geol. Survey Open-File Rept. 77-36, 8 p.

Reimer, G. M., 1977, Fixed volume gas inlet system for an alpha-sensitive cell adapted for radon measurement: U.S. Geol. Survey Open-File Rept. 77-409, 3 p.

Roberts, W. A., and Gude, A. J., 3d, 1953, Uranium-bearing deposits west of Clancy, Jefferson County, Montana: U.S. Geol. Survey Bull. 988-F, p. 69-87.

Sanders, J. W., and Miles, M. J., 1974, Mineral content of selected geothermal waters: Univ. Nevada, Desert Research Inst., Center of Water Resources Research Proj. Rept. 26, 36 p.

Schlundt, Herman, and Moore, R. B., 1909, Radioactivity of the thermal waters of Yellowstone National Park: U.S. Geol. Survey Bull. 395, 35 p.

Scott, R. C., and Barker, F. B., 1962, Data on uranium and radium in ground water in the United States, 1954 to 1957: U.S. Geol. Survey Prof. Paper 426, 115 p.

Scott, R. C., and Voegeli, P. T., Sr., 1961, Radiochemical analyses of ground and surface water in Colorado, 1954-1961: Colorado Water Conservation Board Basic-Data Rept. 7, 27 p.

Sorensen, M. L., and Crittenden, M. D., Jr., 1972, Geologic map of part of the Wasatch Range near North Ogden, Utah: U.S. Geol. Survey Misc. Field Studies Map MF-428, 1 sheet.

Staatz, M. H., and Bauer, H. L., Jr., 1953, Uranium in the East Walker River area, Lyon County, Nevada: U.S. Geol. Survey Bull. 988-C, p. 29-43.

Staatz, M. H., and Carr, W. J., 1964, Geology and mineral deposits of the Thomas and Dugway Ranges, Juab and Tooele Counties, Utah: U.S. Geol. Survey Prof. Paper 415, 188 p.

Stewart, J. H., and Carlson, J. E., 1974, Preliminary geologic map of Nevada: U.S. Geol. Survey Misc. Field Studies Map MF-609, 4 sheets.

Thatcher, L. L., Janzer, V. J., and Edwards, K. W., 1977, Methods for determination of radioactive substances in water and fluvial sediments: Techniques of Water-Resources Investigations of the U.S. Geol. Survey, Book 5, Chap. A5, 95 p.

Whitcomb, H. A., and Lowry, M. E., 1968, Ground-water resources and geology of the Wind River basin area, central Wyoming: U.S. Geol. Survey Hydrol. Inv. Atlas HA-270, 13 p.

White, D. E., Hem, J. D., and Waring, G. A., 1963, Chemical composition of subsurface waters: U.S. Geol. Survey Prof. Paper 440-F, 67 p.

Wollenberg, H. A., 1974, Radioactivity of Nevada hot-spring systems: Geophys. Research Letters, v. 1, no. 8, p. 359-362.

Young, H. W., and Mitchell, J. C., 1973, Geochemistry and geologic settings of selected thermal waters, _in_ Geothermal investigations in Idaho: Idaho Dept. Water Administration, Water Inf. Bull. 30, Part 1, 43 p.

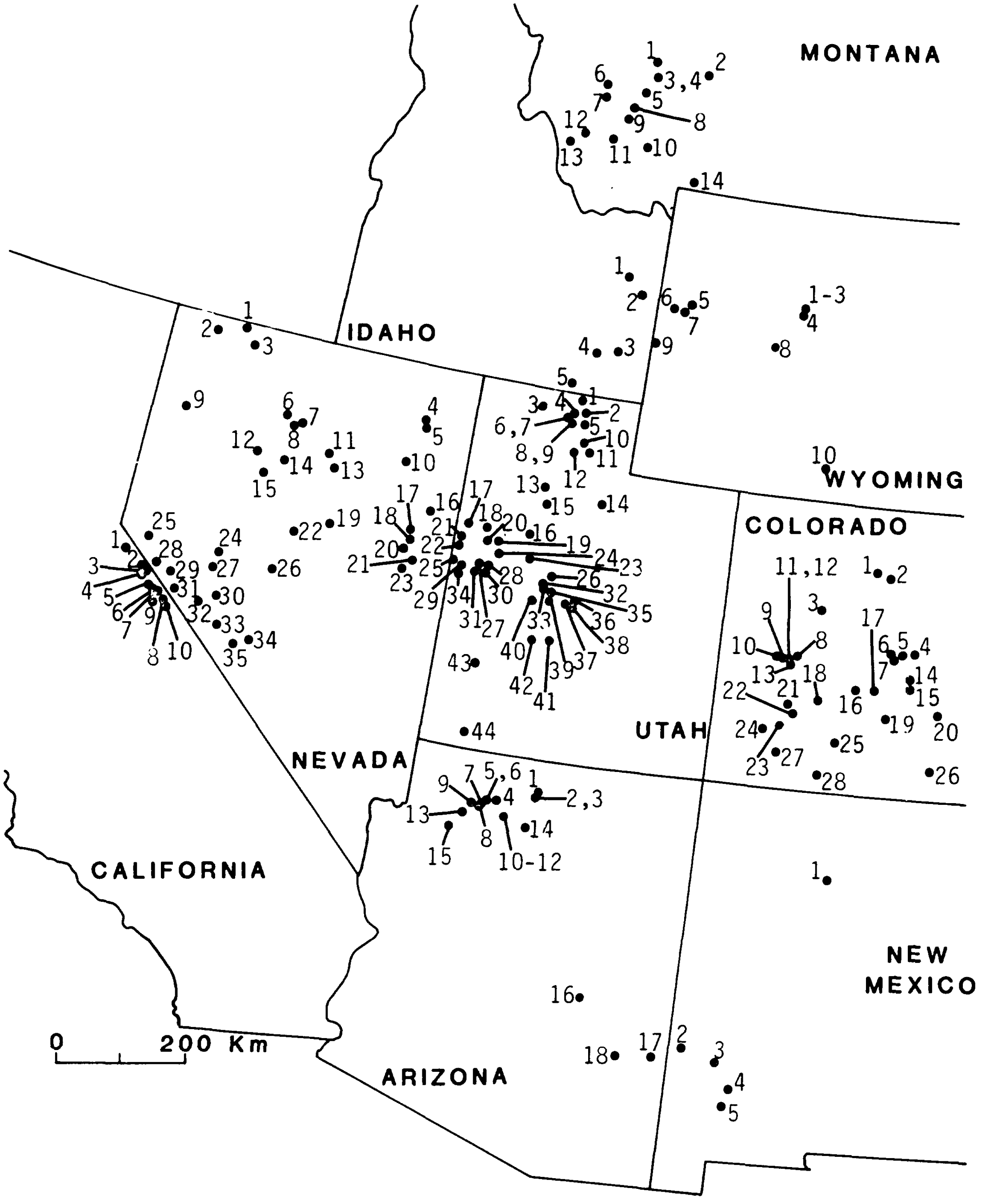

Figure 1.--Mineral-spring sites visited during this study. Numbers in each state correspond to sites described in table 1.

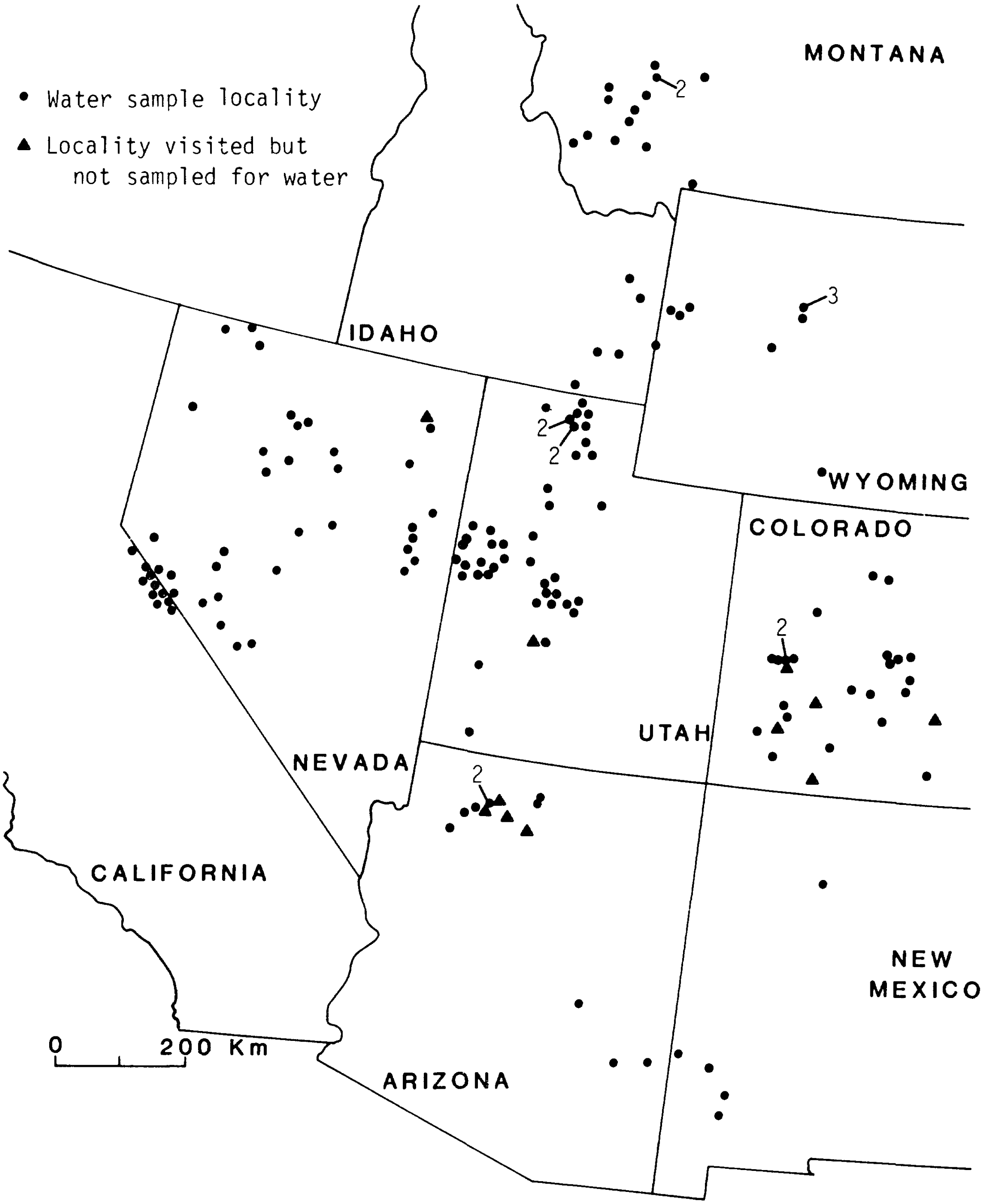

Figure 2.--Water sample localities. Number shows number of sites represented by a dot where more than one site cannot be be shown at this scale.

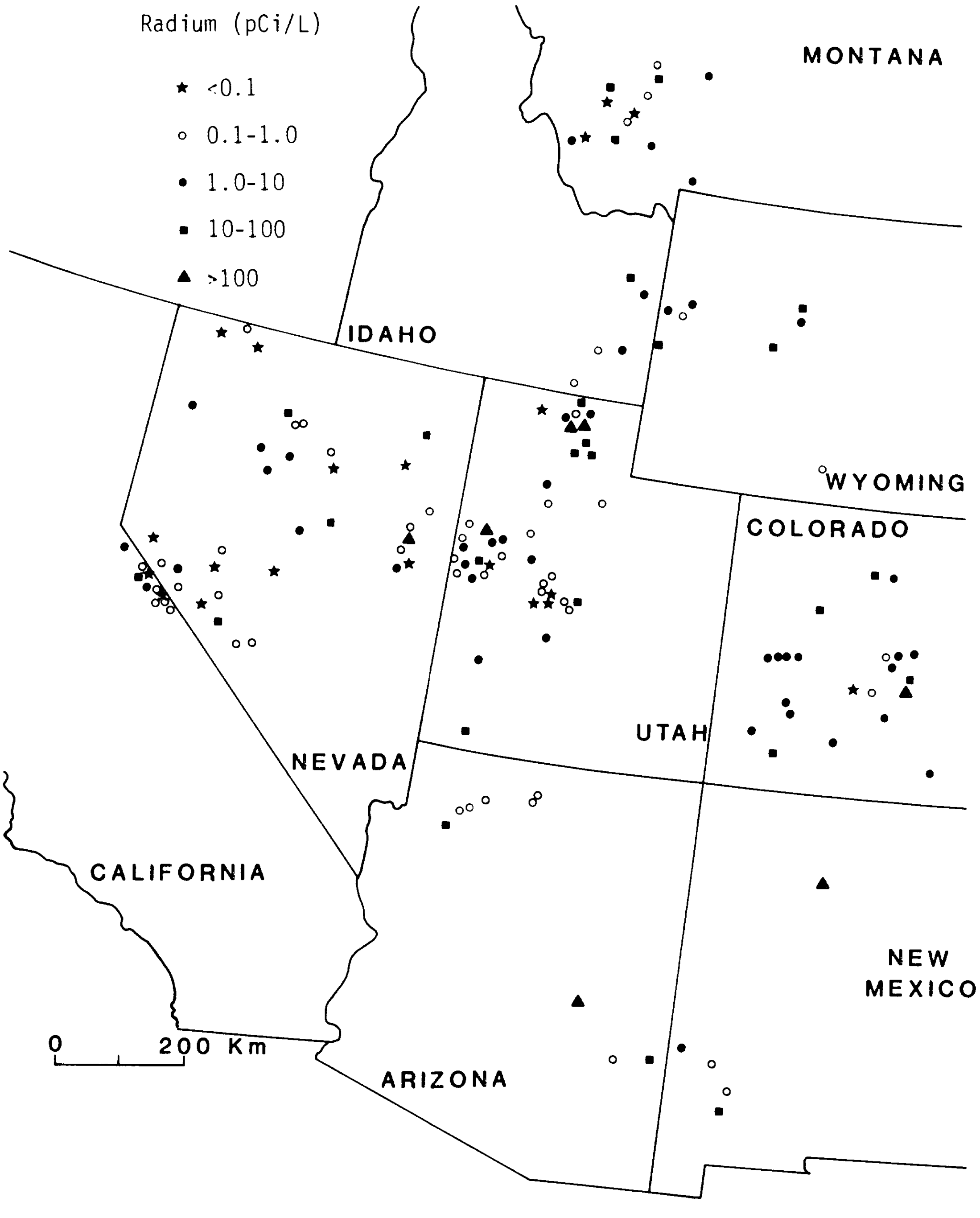

Figure 3.--Radium concentrations in water. Where more than one sample is represented by a point, only the highest value is shown.

Figure 4.--Radium-228 concentrations in water.

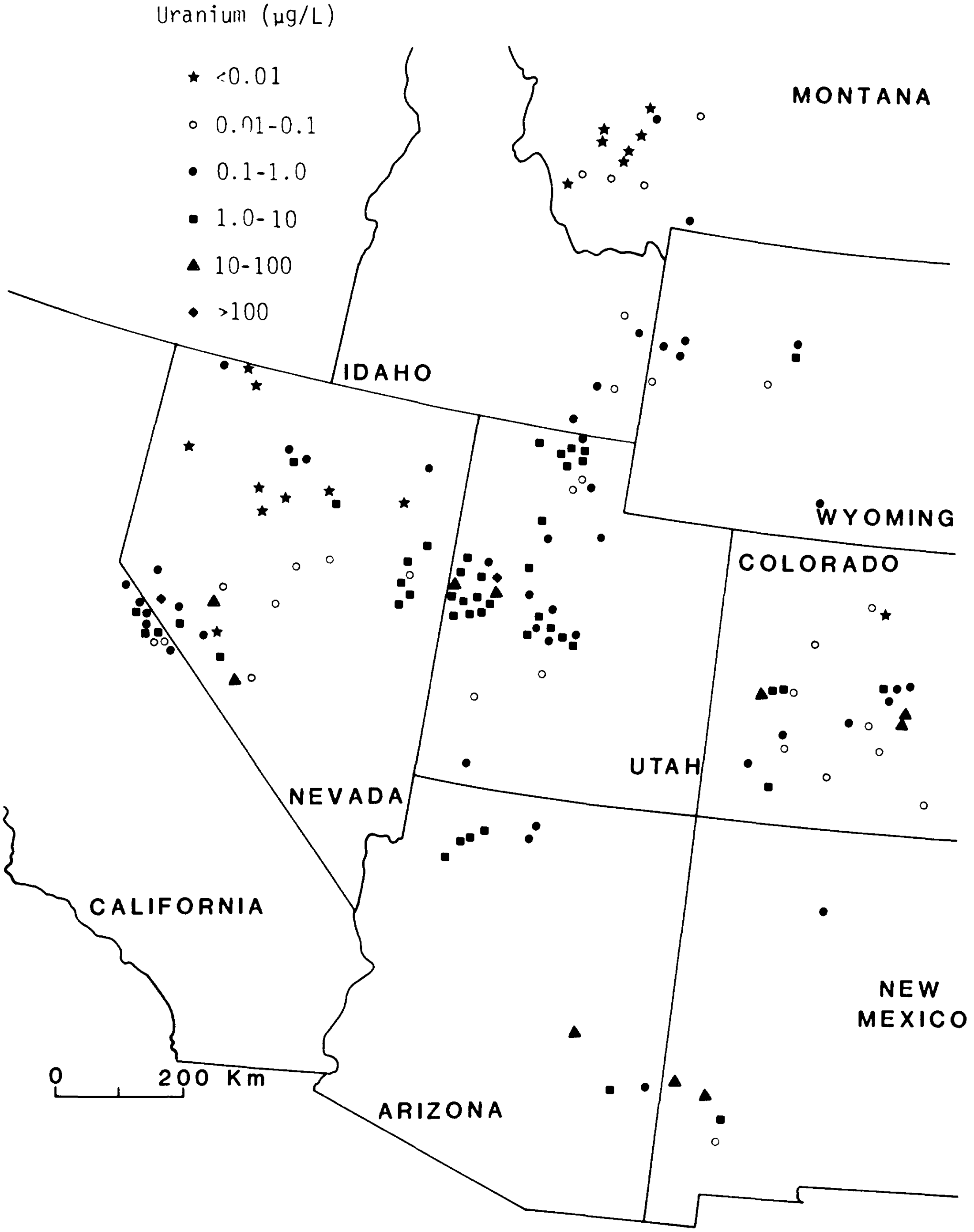

Figure 5.--Uranium concentrations in water. Where more than one sample is represented by a point, only the highest value is shown.

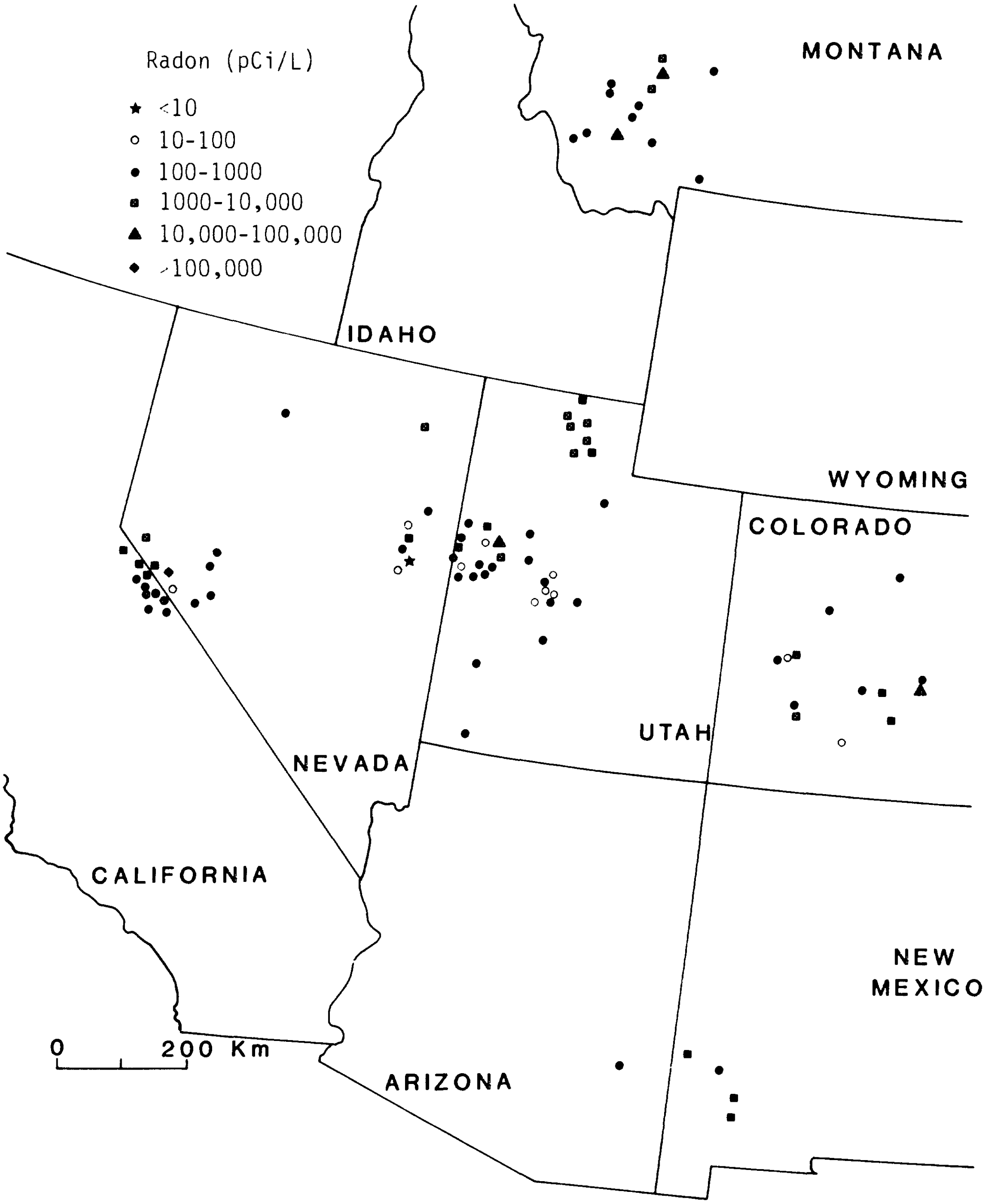

Figure 6.--Radon concentrations in water. Where more than one sample is represented by a point, only the highest value is shown.

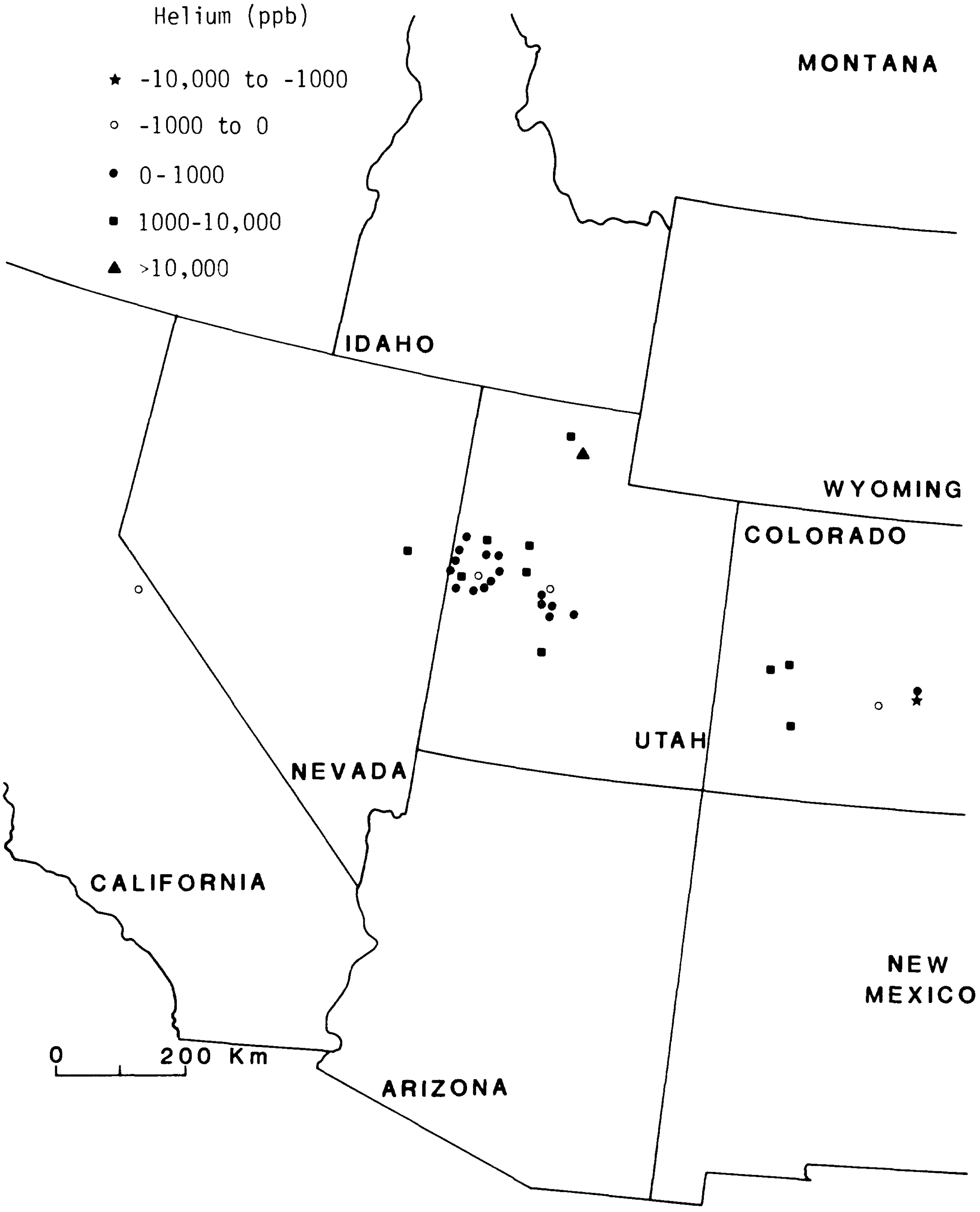

Figure 7.--Helium concentrations in water.

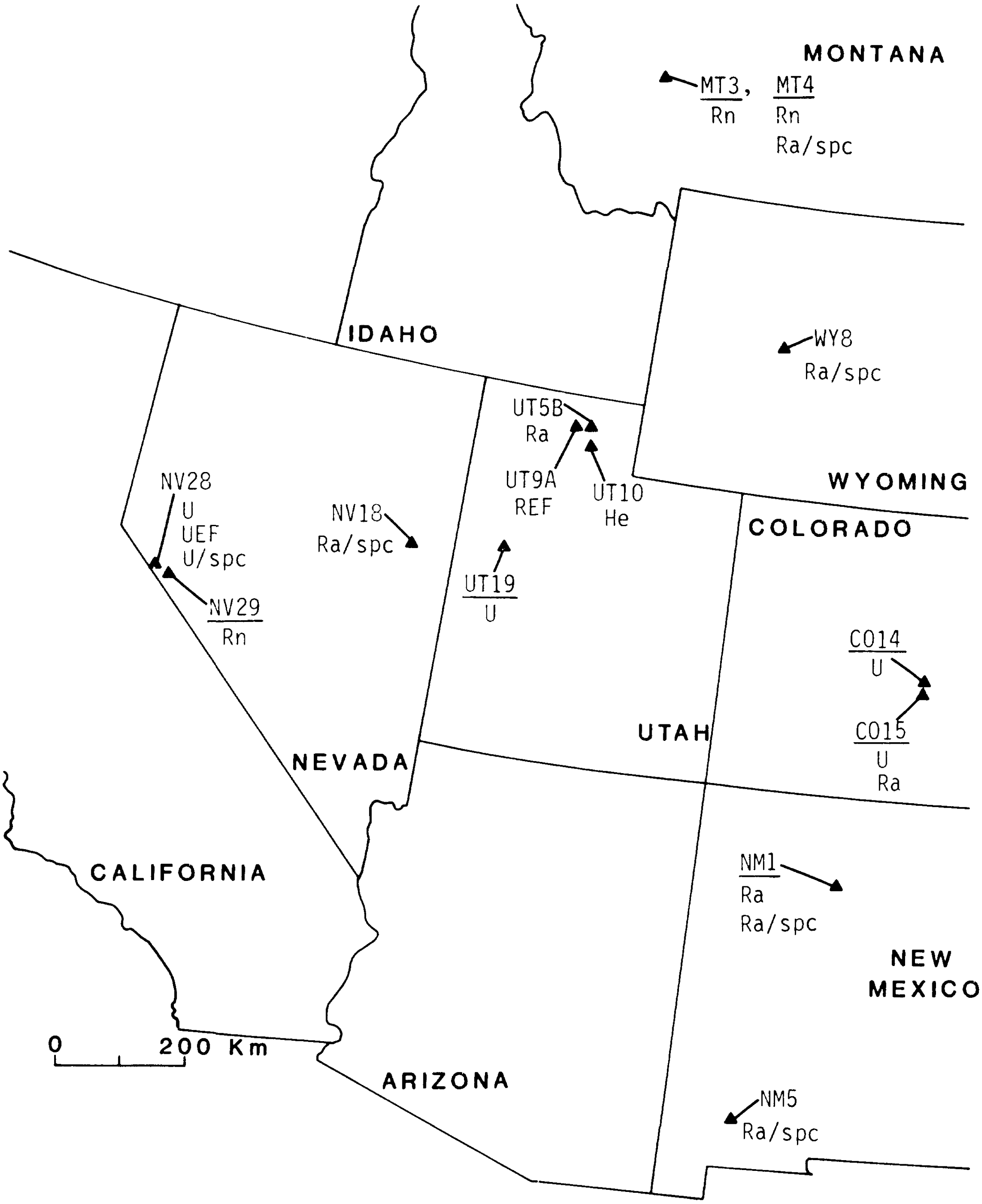

Figure 8.--Water sample localities showing anomalous radioactivety. Underline indicates presence of nearby known uranium occurrences.

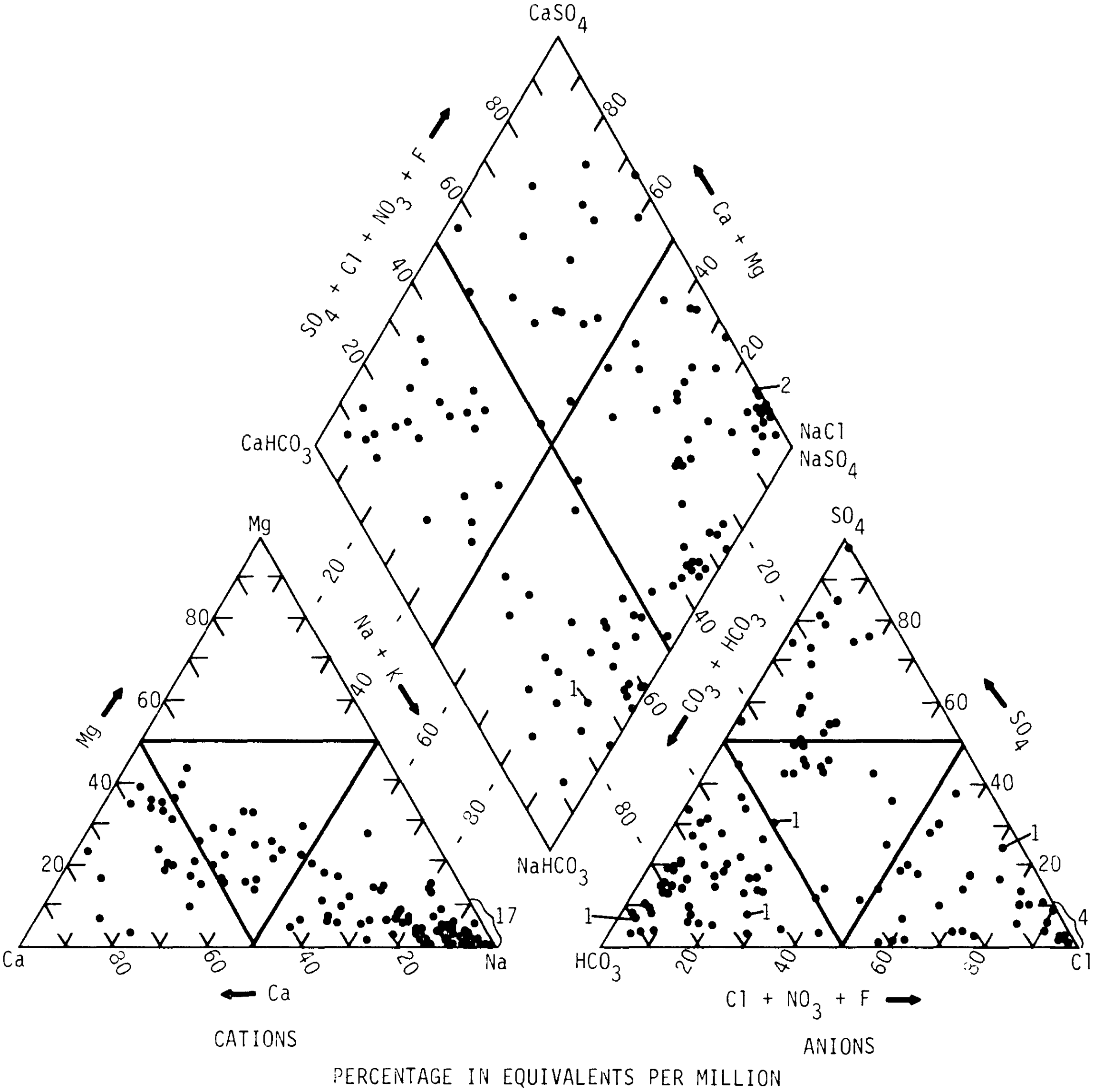

Figure 9.--Major-ion chemistry of sampled waters, showing common water types. Small numbers referring to sample points indicate number of additional samples which plot in the same place as a sample already plotted.

Table 1.--Sample site descriptions

[W, water sample and (or) field measurements; S, precipitate or sediment sample.]

Site No.	Site name	Sample type	Remarks
Arizona			
AZ 1	Vaseys Paradise spring in Grand Canyon	W	Spring issues on right bank of river facing downstream. Sampled at point of issue.
AZ 2	Grand Canyon at river mile 34.1	S	No spring. Travertine forms stalactite-like mass on rock outcrop on right bank of river facing downstream.
AZ 3	Spring in Grand Canyon at river mile 34.2	W	Springs issue in several places from rock outcrop on right bank of river facing downstream. Sampled from several points of issue.
AZ 4	Grand Canyon at river mile 136.7	S	No spring. Damp travertine at base of outcrop on left bank of river facing downstream.
AZ 5	Spring in Grand Canyon at river mile 151.5	W S	Spring issues from rock outcrop on right bank of river facing downstream. Sampled at point of issue. Travertine has formed.
AZ 6	Spring in Grand Canyon at river mile 147.9	W S	Spring issues from rock outcrop on right bank of river facing downstream. Sampled at point of issue. Travertine has formed.
AZ 7	Grand Canyon at river mile 155.8	S	Water seeps from rock ledge on right bank of river facing downstream. Travertine has formed near point of issue.
AZ 8	Havasu Canyon in Grand Canyon	S	Spring issues far upstream. Travertine has formed in creek bed to at least 400 m from mouth of creek on left bank of river facing downstream.
AZ 9	Spring at Fern Glen Canyon in Grand Canyon	W S	Springs issue from rock outcrops on right bank of river facing downstream. Sampled at main (lowest) spring. Travertine forms deposits.
AZ10	Grand Canyon at river mile 114.5	S	No spring. Damp travertine coats rocks on left bank of river facing downstream.
AZ11	Grand Canyon at river mile 115.5	S	No spring. Travertine coating on float boulder on left bank of river facing downstream.
AZ12	Grand Canyon at river mile 116.5	S	No spring. Travertine coating on float boulder at mouth of creek on left bank of river facing downstream.
AZ13	Lava Falls warm springs in Grand Canyon	W S	Springs issue over length of several hundred meters on left bank of river facing downstream. Sampled at several points of issue. Travertine forms deposits at several sites.
AZ14	Pumpkin Spring in Grand Canyon	W S	Spring issues in pool on travertine mound and flows out to river at upstream end of pool on left bank of river facing downstream. Sampled at pool. Travertine is forming around spring.
AZ15	Grand Canyon at river mile 77	S	No water. Inactive travertine at dry spring on left bank of river facing downstream.
AZ16	The Salt Banks springs	W S	Springs issue in three areas on north side of river along river bank. Sampled at easternmost spring area near river level, where water flows from older deposits. Extensive cliff-like travertine apron covers river bank for about 0.5 km. Deposits are actively forming where water rises in pools and overflows down apron as much as 30 m to river.
AZ17	Clifton Hot Spring	W	Springs seep from gravel in numerous places at river level on east bank of river. Sampled at one point of issue of high temperature.
AZ18	Indian Hot Springs	W	Springs issue in pools behind hotel building of old spa. Sampled at one pool. Water used for bathing.
California			
CA 1	Grovers Hot Springs	W S	Springs issue in numerous orifices near base of hillside. Sampled at main spring, which forms 1-m-diameter pool at crest of low travertine mound at west end of spring area. Travertine forms apron in areas where springs issue. Water used for swimming pool. State Park.
CA 2	Wild Horse Spring	W	Spring issues through horizontal metal pipe at least 1 m long. Sampled where water flows from pipe. Water used for stock.
CA 3	Lava Springs	W	Spring rises near base of outcrop at bend in road. Sampled at point of issue.
CA 4	Fales Hot Springs	W S	Spring rises in 3-m-diameter pool with vigorous bubbling of large-volume flow on south side of highway. Sampled at pool edge. Water flows down valley to west, where travertine is forming in places along the drainage. North of highway is large inactive travertine mound with 20-m-diameter circular depression at crest, about 30 m above level of present spring discharge. Water used for swimming pool.
CA 5	Travertine Hot Springs at Bridgeport	W S	Springs issue in large area on hillside. Sampled at main spring at highest level of spring area, where water rises in 0.5-m-diameter cement cylinder. Extensive aprons and ridges of inactive travertine cover the area. Fresh travertine is forming at current orifices. Travertine has been mined for stone.
CA 6	Spring on Big Alkali Flat in Bodie Hills	W	Spring rises in shallow pond about 10 m diameter. Sampled at edge of pond.
CA 7	Warm spring in Bodie Hills	W	Spring rises near base of low hill and forms marshy pond. Sampled near point of issue at north edge of pond.
CA 8	Sulphur artesian well at Mono Lake	W W	Water rises through metal pipe about 10 cm diameter and flows out at ground level. Sampled at point of issue. H_2S smell.
CA 9	Hot spring at Mono Lake	W S	Spring rises underground and flows about 100 m north through 15-cm-diameter metal pipe to 1-m-long cement-walled rectangular pool. Vertical vent pipe near source allows escape of steam. Sampled where water flows into pool from pipe. Fresh travertine is forming at water level around edge of pool.
CA10	Warm springs at Mono Lake	W	Spring rises in sandy 0.3-m-diameter pool east of Mono Lake. Sampled at point of issue.

Table 1.--Sample site descriptions--Continued

Site No.	Site name	Sample type	Remarks
Colorado			
CO 1	Sulphur Springs near Kremmling	W S	Springs issue in numerous places on west-facing slope. Sampled at main spring by road in gulley to north of other springs. H_2S smell.
CO 2	Hot Sulphur Springs	W S	Springs issue in several places on hillside behind motel. Main spring is piped underground to motel. Sampled at spring of smaller flow. Some precipitates are forming in drainage. H_2S smell.
CO 3	Glenwood Springs	W S	Springs issue at several places along river. Main spring that feeds swimming pool rises in circular 10-m-diameter cement-walled pool with vigorous bubbling of large-volume flow. Sampled at outlet from main spring. Precipitates have formed at pool edges.
CO 4	Sulphur Springs at Sulphur Mountain	W S	Springs seep from ground on south side of hill. Sampled at one place where bubbles rise with water. Water used for stock. Sample PAR 1 of Mallory and Barnett (1973).
CO 5	Hartsel Hot Springs	W S	Springs issue in several places at base of hill south of Hartsel. Sampled inside small wooden bathhouse near large building, where water rises in pool about 0.5 m diameter. Water used for bathing. Sample PAR 5 of Mallory and Barnett (1973).
CO 6	Salt Spring near Antero	W	Springs issue from base of low slope east of road and flow east. Sampled near point of issue. Sample PAR 2 of Mallory and Barnett (1973).
CO 7	Salt Works spring near Antero	W S	Spring issues from pipe next to old salt works building. Sampled at point of issue. Water used for stock. Sample PAR 3 of Mallory and Barnett (1973).
CO 8	Colonel Chinn artesian well	W	Water flows from valved wellhead on terrace south of river. Sampled at wellhead. H_2S smell.
CO 9	Sulphur Gulch spring	W S	Springs issue in three 2- to 3-m-diameter pools in rock outcrops in lower end of gulley. Sampled at edge of middle pool. H_2S smell.
CO10	Austin springs	W S	Several springs issue near base of hill or in gulleys on hillside. Sampled northermost spring which rises at base of outcrop in pool 0.5 m diameter. Travertine shelf and apron are present farther south toward river. H_2S smell.
CO11	Fish hatchery adit spring	W S	Spring issues in dugout "adit" about 2 m high and 3 m deep in hillside on north side of road. Sampled at entrance to "adit" at edge of pool. Soil bank at edge of road contains travertine-cemented talus. H_2S smell.
CO12	Doughty springs (A, Bathtub spring; B, Alum spring)	W S	Springs issue at base of rock outcrops on north side of river. Travertine forms shelf 300 m long by 30 m wide between outcrops and river. Sampled one spring at east end of shelf which rises in small 0.5-m-diameter pool and flows into largest blue pool on shelf; also sampled spring at west end of shelf which flows from rock crevice and into black pool. Travertine is forming along drainages and at shelf edge. H_2S smell.
CO13	Alum Gulch	S	Water seeps from outcrops on west side of gulley. Alum deposits have formed on underside of overhanging ledges. Alum has been mined.
CO14	Yellow Soda Spring near Guffey	W S	Springs issue in pools on travertine mound on hillside. Sampled at point of issue of main 2-m-diameter pool at crest of mound. Precipitate is forming at present orifice. Sample PAR 4 of Mallory and Barnett (1973).
CO15	Taylor Soda Spring	W S	Springs issue in large area about 100 by 500 m at base of hill. Sampled at spring at southwest edge of area. Travertine mounds up to 0.5 m high surrounded some of the orifices. Precipitate is forming in some springs. Sample FRE 1 of Mallory and Barnett (1973).
CO16	Waunita Hot Springs	W	Springs issue at base of hill near resort and also along south side of creek several hundred meters to northwest. Tested where water issues from underneath small building in highest part of spring area along creek.
CO17	Poncha Hot Springs	W S	Springs issue at several places on steep slope. Sampled at No. 13 where water rises in 0.5-m-square cement-walled orifice. Inactive travertine forms numerous mounds on slope. Sample CHA 6 of Mallory and Barnett (1973). Water from springs flows underground through pipes to reservoir and then to town of Poncha Springs.
CO18	Spring near Powderhorn	S	Springs issue at several places on southwest side of valley. Inactive travertine forms two aprons about 200 by 400 m on northeast side of road west of Cebolla Hot Springs.
CO19	Mineral Hot Springs	W S	Springs issue in several places on or near broad mounds on valley floor. Tested at flowing well in northeast part of spring area. Mounds are inactive travertine. Sample similar to SAG 4 of Mallory and Barnett (1973).
CO20	Lower Red Creek soda springs	S	No water. Two 3-m-high mounds having 1-m-dimeter depressions in crests are present in 50-square-m area of inactive travertine.
CO21	Orvis Hot Spring	W	Spring issues at bottom of circular depression on top of inactive travertine shelf. Sampled at edge of pool.
CO22	Ouray hot springs	W S	Springs issue on hillside behind motel about 15 m up slope and also in cave on river bank about 5 m above river level several hundred meters west of motel. Sampled at point of issue behind motel, where water rises in covered pool about 1 m square. Inactive travertine forms large apron below point of issue. Water used for hot tubs and for municipal swimming pool.
CO23	Ophir Iron Spring	S	Spring issues from dugout adit. Tested at point of issue. Iron-rich travertine forms deposits near spring and at base of hill. Travertine has been mined.

Table 1.--Sample site descriptions--Continued

Site No.	Site name	Sample type	Remarks
Colorado--Continued			
CO24	Dunton Hot Springs	W S	Spring issues near base of hill. Tested at point of issue. Travertine forms thin depoit near spring, below bathouse.
CO25	Wagon Wheel Gap hot springs	W	Springs issue in two places, one near old spa building and one upstream, or south, from building. Tested at northern spring. Sample MIN 2 of Mallory and Barnett (1973). Water used for bathing.
CO26	Sulphur Springs near La Veta	W	Springs issue in two places at base of outcrop, one 15 m upstream, or west, from other. Tested at eastern spring. Sample HUE 5 of Mallory and Barnett (1973). H_2S smell.
CO27	Bakers Bridge hot springs near Durango	W S	Springs issue on east side of highway in large pond and on west side of highway about 50 m up hillside. Sampled at edge of large pond. Travertine froms large apron below springs on hillside west of highway.
CO28	Pagosa Springs	S	Springs issue near motel and along south bank of river. Precipitates are forming around orifices and along drainages. H_2S smell.
Idaho			
ID 1	Heise Hot Springs	W S	Spring issues on hillside about 10 m above river on north side of river and south of road. Point of issue is enclosed in cement structure. Sampled at leak in pipe 7 m from source. Travertine is forming where water leaks from pipe. Water used for swimming pool. H_2S smell.
IO 2	Fall Creek Mineral Springs	W S	Springs issue on south bank of Fall Creek. Sampled at point of issue of main spring, where travertine apron is actively forming. Inactive travertine mounds occur downstream.
ID 3	Soda Springs artesian well(?)	W S	Water gushes horizontally out of pipe extending about 7 m from cement building presumably over source. Sampled at end of pipe. Building is on flank of large travertine mound about 15 m high. Fresh travertine is forming where water falls on mound.
ID 4	Lava Hot Springs	W	Springs issue at base of cliff. Sampled at point of issue. Inactive travertine coats cliff and forms grotto-like deposits nearby. Water used for swimming pool.
ID 5	Pleasantview Warm Springs	W	Spring issues in broad area, seeping out of gravel at pond edges. Sampled at one point of issue.
ID 6	Spring	W S	Confidential.
Montana			
MT 1	Broadwater hot well	W S	Water issues in seeps and has been tapped by wells. Sampled at 10-cm-diameter wellhead 1 m above ground. Water had to be pumped out from about 1 m depth because it was not flowing. Being developed for geothermal energy. H_2S smell at one steam vent.
MT 2	White Sulphur Springs	W	Water issues from 0.3-m-diameter pipe in soil bank. Sampled at pipe. Pinkish white precipitates form thin coatings on pebbles where water flows to west. H_2S smell.
MT 3	Alhambra Hot Springs	W S	Springs issue in cement-walled covered orifices. Sampled at upper end of main orifice near gazebo. Edge of travertine shelf crops out about 5 m north of springs. Some spring water issues from pipe and is now forming travertine on the shelf slope.
MT 4	Alhambra warm well	W	Water issues from pipe about 1 m above ground. Sampled at pipe.
MT 5	Boulder Hot Springs	W S	Main spring issues in 3-m-diameter cement tank on hillside behind hotel. Sampled at end of 5-m-long pipe extending from side of tank. Some encrustations have formed on pipe. Other smaller springs issue farther up hillside. Water used for swimming pool.
MT 6	Warm Springs at State Hospital	W S	Spring issues at top of large travertine mound which stands about 15 m above valley floor. Sampled at outlet pipe at base of gazebo on top of mound, where water is now forming travertine as it flows down the slope of the mound.
MT 7	Gregson Hot Springs	W	Springs issue in tanks covered by wooden pyramidal roofs. Sampled in cement-walled and covered cylindrical 2-m-diameter collecting tank a few meters east of springs. Water was taken from the north one of the two pipes on the west side of the tank as it emptied into the tank. H_2S smell. Water used for swimming pool.
MT 8	Pipestone Hot Springs	W	Water issues from 1-m-high 5-cm-diameter vertical pipe at south side of creek, several meters southwest of gazebo. Sampled at pipe.
MT 9	Silver Star hot springs	W	Springs issue in walled and grated orifices on gentle hillside. Sampled at main spring issuing in 1-m-square cement-walled pool. Water used for swimming pool.
MT10	Norris Hot Springs	W	Spring issues from 3-m-high vertical pipe at edge of swimming pool on north side of valley. Sampled at pool edge. Other springs issue on the south side of the valley in a reedy area.
MT11	Biltmore Hot Springs	W S	Water is tapped by 8-m-deep well. Sampled at spigot attached to well casing. Travertine encrustations coat drainage area near well. Water used for swimming pool.
MT12	Elkhorn Hot Springs	W	Springs issue in fenced grassy area in valley. Sampled at uppermost spring where it issues into a small natural catchment basin in outcrop. Water used for swimming pool.
MT13	Jardine Hot Spring near Jackson	W	Spring issues in 4-m-square cement-walled pool with vigorous bubbling of large-volume flow on slight rise in valley floor. Sampled at pool edge.

Table 1.--Sample site descriptions--Continued

Site No.	Site name	Sample type	Remarks
			Montana--Continued
MT14	La Duke Hot Spring	W S	Spring issues in long cement-walled covered orifice along east side of highway at base of hill. Sampled at outlet pipe on west side of highway, where water gushes out and is forming a travertine apron. Radon sample was taken at small-flow spring issuing from gravel slope south of main cement-walled orifice on east side of highway.
			Nevada
NV 1	Baltazor Hot Spring	W	Springs issue on valley floor. Largest one forms 4-m-diameter pool in grassy area. Sampled at spring 30 m east of house, where it rises in 0.5-m-diameter metal cylinder set in ground.
NV 2	Virgin Valley Warm Spring	W	Spring issues in pool near base of hill. Sampled at pool outlet.
NV 3	Howard Hot Spring	W	Springs issue in several places on gentle slope. Sampled at main spring on southwest side of area, where water forms pools several meters diameter.
NV 4	Hot springs near Wells	S	Springs issue in large area on hillside. Travertine forms extensive apron.
NV 5	Threemile Sulphur Spring	W S	Spring issues from crevice in rock outcrop and forms pool. Sampled at point of issue. H_2S smell.
NV 6	Golconda Hot Spring (A, main spring; B, smaller spring)	W S	Springs issue in large area. Sampled where water pours from ground at outlet from highest level pool in northeast part of area. Three pools here are 5 to 6 m diameter and are rimmed with travertine. Also sampled in 1977 was small pool in west part of area near radioactive spot. Travertine has been mined for Mn.
NV 7	Plank Spring	W	Spring issues in 1-m-square cement-walled pool. Sampled in pool in 1977. Spring dry in 1980.
NV 8	Brooks Hot Spring	W	Spring issues in depression on valley floor about 5 m diameter. Sampled at point of issue at south edge of spring pool.
NV 9	Great Boiling Spring at Gerlach	W	Springs issue in numerous places in broad area. Sampled at edge of main spring near parking area where it rises in pool about 10 m diameter with vigorous bubbling of large-volume flow.
NV10	Sulphur Hot Springs in Ruby Valley	W S	Springs issue in numerous places on valley floor. Sampled at hottest spring tested, which rises in 2-m-diameter pool. H_2S smell.
NV11	The Geysers at Beowawe	W S	Springs issue on terrace several hundred meters long on north slope of hill. At least two wells tap water. Main stream of water roars vertically about 15 m into air. Sampled at pipe about 30 m east of main spout, where water comes out with less force. Terrace is formed by travertine. New deposits are forming around pipes.
NV12	Kyle Hot Springs	W S	Springs issue in several places on low mound about 50 m across. Sampled at hottest spring at point of issue in depression 1.5 m below surface. Low mound has about 5 m relief and is composed of inactive travertine. H_2S smell. Water used for bathing.
NV13	Hot Spring Point hot spring	W	Spring issues about 100 m northwest of rock quarry on hillside. Sampled where spring rises into 1-m-diameter pool.
NV14	Buffalo Valley Hot Springs	W S	Springs issue at many points over broad area of valley floor. Sampled at one spring with enough flow to use. Small travertine cones up to 0.7 m high surround many springs. Water used for stock.
NV15	Sou Hot Springs	W S	Springs issue at several places near base of hill. Sampled at outlet of spring of largest flow most accessible between two travertine mounds. Two broad inactive travertine mounds are about 5 m high.
NV16	Collar and Elbow spring	W	Spring issues at base of grass-covered low mound on valley floor. Water forms shallow pool with no obvious point source. Sampled at edge of pool.
NV17	Borchert John spring	W	Spring issues from bank of alluvium and flows northeast about 50 m into cement-walled pool which feeds into 10-cm-diameter pipe leading toward valley floor. Sampled at cement-walled pool.
NV18	Monte Neva Hot Springs	W S	Spring issues from cut in large travertine mound several hundred meters diameter. Sampled at point of issue in cut 2 m below crest of mound. Fresh travertine is forming along edge of drainage where water flows out to west and north. Faint H_2S smell.
NV19	Bartine Hot Springs	W S	Springs issue in two places. Sampled larger spring, which rises through 10-cm-diameter pipe into 1-m-square cement-walled pool. Inactive travertine forms mounds about 1 m high in area.
NV20	Steptoe warm springs	W	Springs issue in several places along gentle slope and feed a collecting pond. Sampled at spring that issues at southwest side of pond and flows 20 m to the pond. Water used for irrigation.
NV21	McGill Spring	W	Spring issues from 0.5-m-diameter pipe in ground into large pond used for swimming. Sampled at pipe.
NV22	Spencer Hot Springs	W S	Springs issue on top of large broad apron. Sampled at one point of issue where water rises near metal pipe in pool about 1 m diameter. Apron is inactive travertine.
NV23	Lackawanna Springs	W	Spring issues at base of hill where water forms 1-m-diameter pool. Sampled near pipe below water surface, where water seems to be entering pool.
NV24	Rawhide hot spring	W	Spring issues from valley floor. Sampled near point of issue of main spring near house.

Table 1.--Sample site descriptions--Continued

Site No.	Site name	Sample type	Remarks
			Nevada--Continued
NV25	Nevada Hot Springs (A, to north; B, to south)	W	Springs issue from talus bank about 5 m above road level and flow along ditch in talus before descending to valley floor. Sampled where water flows from talus in middle of spring area and also where water flowed from pipe set in ground at north end of spring area in 1977 (pipe dry in 1979).
NV26	Darrough Hot Springs	W S	Water gushes horizontally from valved pipe at wellhead in spring area on valley floor. Sampled where water emerges from pipe. Encrustations have formed on wellhead apparatus.
NV27	Spring in Gillis Range	W	Spring issues on slope and flows about 3 m through 3-cm-diameter pipe. Sampled where water flows from pipe. Water used for stock.
NV28	Spring in Nye Canyon	W	Spring issues at base of outcrop in ditch on north side of road. Sampled at point of issue, where water forms 1-m-diameter pool. Water used for stock.
NV29	Grant View hot springs	W S	Springs issue at base of outcrop on southeast side of river. Sampled at main spring, which rises in 0.5-m-diameter pool.
NV30	Soda Springs at Sodaville	W S	Springs issue in several places on valley floor on west side of highway. Sampled at edge of spring in north end of area at highest altitude of slope, where water rises in 3-m-diameter pool.
NV31	Spring near Aurora	W	Spring rises in 1-m-diameter metal barrel at base of hill. Sampled in barrel.
NV32	Spring at Teels Marsh	W S	Spring issues in irregular-shaped pond few meters diameter. Sampled at edge of pond.
NV33	Gap Spring	W S	Spring issues on side of mound near base of hill. Sampled at point of issue, where water rises in 1-m-diameter pool. Mound of inactive travertine is about 500 m long, 100 m across, and 15 m high.
NV34	Alkali Hot Spring	W S	Spring issues from dugout, partly collapsed adit and also flows from about 15-cm-diameter pipe 30 m from adit. Sampled where water pours from end of pipe. Large inactive travertine shelf is present nearby.
NV35	Silverpeak artesian well(?)	W	Water gushes from pipe leading from building over spring source at base of east side of small hill and empties into pool. Sampled at end of pipe. Could not locate spring shown on 7 1/2-min. topographic map.
NV36	Spring	W	Confidential.
			New Mexico
NM 1	Soda Dam Hot Springs	W S	Springs issue at several places in and near "dam," which is a large ridge of travertine extending most of the way across river. Sampled at one point of issue about 40 m downstream from "dam" on northwest bank of river about 1 m above river level, where radioactivity was relatively high.
NM 2	San Francisco Hot Springs	W	Spring issues at river level on east bank of river. Tested at spring pool.
NM 3	Gila Hot Springs	W	Springs issue at numerous places along east bank of creek. Tested at one point of issue.
NM 4	Mimbres Hot Springs	W	Springs issue on hillside behind house and form small creek. Tested at at one point of issue.
NM 5	Faywood Hot Springs	W S	Spring issues near top of inactive travertine mound about 20 m high. Sampled at point of issue, where water rises in pool about 2 m diameter.
			Utah
UT 1	Udy Hot Springs	W S	Springs issue in numerous places in river and on west bank of river. Sampled at one spring in central part of area. Water possibly treated with $CuSO_4$ to prevent algae growth. Travertine deposits have formed in area. Water used for swimming and bathing.
UT 2	Garland Springs	W	Spring issues into large pond. Small building located over spring source. Sampled at pipe at head of pond.
UT 3	Locomotive Springs	W	Springs issue in several places on mudflats. Sampled Baker Spring at edge of large pond about 15 m diameter where water seems to rise.
UT 4	Salt Spring near Tremonton	W	Springs issue at base of hill. Sampled at one of numerous points of issue near west side of area.
UT 5	Crystal Springs (A, cold spring; B, hot spring)	W S	Hot spring issues from underneath stone wall near swimming pool. Sampled at point of issue where water pours out. Encrustations of travertine form along drainage. Cold spring issues in pool a few meters north of hot spring. Water used for swimming pool.
UT 6	Poison Spring	W S	Spring issues in 20-m-diameter irregular-shaped shallow pond. Point of issue is not obvious. Sampled at edge of pond.
UT 7	Painted Rock spring	W S	Spring issues at base of rock outcrop. Sampled at point of issue.
UT 8	Little Mountain hot spring	W	Spring issues at southwest end of Little Mountain on south side of highway. Sampled where water pours from horizontal pipe conduit.
UT 9	Stinking Hot Springs (A, near cliff; B, near bathhouse)	W S	Springs issue at base of outcrop at southeast end of Little Mountain on north side of highway. Sampled at spring closest to outcrop near east end of spring area a few meters west of southeast point of outcrop. Also sampled on south side of highway at intake to bathhouse, where water source is not obvious. Travertine forms deposits at and below ground level (no mounds), and precipitates coat drainages. H_2S smell. Water used for bathing. Travertine has been mined for barite.

Table 1.--Sample site descriptions--Continued

Site No.	Site name	Sample type	Remarks
			Utah--Continued
UT10	Utah Hot Springs	W S	Springs issue near base of cliff. Largest flow rises in concrete tank and flows out through pipes and then under RR track to west. Sampled in 1976 at pipe outlet; sampled in 1980 in newly exposed concrete tank. Iron-rich travertine forms low-lying shelf on west side of RR tracks.
UT11	Ogden hot spring	W S	Springs issue in two places on hillside on south side of river. Sampled at eastern spring. Travertine forms deposits around spring.
UT12	Hooper Hot Springs	W S	Springs issue in marshy area on top of low mound on mudflats. Sampled at one point of issue at west edge of mound.
UT13	Grantsville Warm Springs	W S	Springs issue in numerous places on mudflats. Sampled at one spring near end of road having relatively low specific conductance and temperature. Water rises in circular travertine pools whose rims are about 1 m high. Travertine is present over area several hundred meters square.
UT14	Midway Hot Springs	W S	Springs issue in numerous places on valley floor. Sampled one spring near road (not pot C-2 of Baker, 1968). Inactive travertine forms extensive deposits in area. Water used for swimming pool.
UT15	Morgan Ranch Warm Spring	W	Spring rises in oblong pond about 30 m long. Point of issue not obvious. Sampled at southwest edge of pond.
UT16	Coyote Springs in Simpson Mountains	W	Spring issues from steep hillside. Sampled 1 m from point of issue.
UT17	Rock Springs	W	Spring issues in grassy area on slope. Sampled at point of issue. Water used for stock.
UT18	Wilson Health Springs	W S	Springs issue at tops of several large low mounds on mudflats. Sampled at edge of 20-m-diameter pool at crest of third mound northeast from southwest end of spring group. Travertine forms the mounds and is forming at the edges of the pools.
UT19	Wildhorse Spring	W S	Spring issues from ground through 5-cm-diameter pipe into 1-m-square cement-walled covered tank. Sampled where water flows from pipe. Travertine-cemented colluvium forms eroded shelf behind spring. Metal tank 8 m diameter apparently collects water flowing underground from sampled spring. Water flows from metal tank and is forming travertine encrustations in trough. Water used for stock.
UT20	Cane Springs	W S	Spring issues into peaty area and forms pool about 10 m diameter. Sampled at pool edge. Water used for stock.
UT21	Trough Spring	W	Spring issues from colluvium on hillside. Pipe funnels flow into cement-lined trough. Sampled where water flows from pipe into trough. Tested at point of issue. Water used for stock.
UT22	Lime Spring	W S	Spring seeps into 10-m-diameter collecting pond from colluvium on gentle slope. Sampled at seep on west edge of pond. Water used for stock.
UT23	Baker Hot Springs	W S	Springs issue over large area of valley floor. Sampled at edge of 10-m-long irregular-shaped pool at west-central edge of spring area. Travertine forms extensive low mounds and hummocky terrain. Travertine has been mined for Mn.
UT24	Schoenburger Spring	W	Spring issues into 1-m-square cement-walled covered pool at base of slope. Sampled in pool.
UT25	Gandy Warm Springs	W	Springs issue along base of cliff and flow down into natural pool. Sampled at one spring west of the pool. Travertine forms large shelf between cliff and pool, but no fresh travertine is forming. Water used for swimming.
UT26	Mourning Dove Spring	W	Spring issues at base of cliff and flows through 3-cm-diameter pipe into cylindrical cement pool. Sampled at end of pipe, where water flows into pool. Water used for stock.
UT27	Coyote Spring in Tule Valley	W	Spring issues into 1-m-diameter metal cylindrical tank on valley floor. Sampled in tank.
UT28	Swasey Spring	W	Spring issues into cylindrical metal container and drains out through pipe emerging from ground 3 m below container. Sampled at end of pipe.
UT29	Bishop Springs	W	Main springs issue at Twin Springs, two ponds about 10 m diameter on valley floor. Sampled at edge of south pond.
UT30	Stove Spring	W	Spring issues from bank into 3-m-long 3-cm-diameter pipe. Sampled at end of pipe, where water flows into trough. Water used for stock.
UT31	Tule Spring	W	Spring issues in reedy area on valley floor. Sampled at 1-m-diameter pool at south end of marshy area.
UT32	First Spring	W	Spring issues through plastic hose into trough. Sampled at end of hose. Water used for stock.
UT33	Whisky Spring	W	Spring issues from colluvial bank in valley. Sampled at point of issue.
UT34	Knoll Springs	W	Springs issue as seeps at sides or bases of several 6- to 10-m-high silt- and grass-covered mounds. Sampled at 1-m-diameter pool in hummocky ground in northeast part of spring area.
UT35	Mud Spring	W	Spring issues in marshy area on gentle slope. Sampled at 0.8-m-diameter metal tank in marshy area. Water used for stock.
UT36	Stinking Springs near Manti (A, in reeds; B, near	W S	Springs and seeps issue in several places on hillside. Sampled at northeasternmost spring, which has largest flow, and at spring near corral. Travertine apron extends outward from spring near corral to southwest. Precipitates are forming in drainages.
UT37	Fayette Springs	W	Spring issues in grassy area on hillside. Sampled at point of issue. Water used for town water supply.
UT38	Ninemile spring	W	Spring issues near base of hill. Sampled at point of issue.

Table 1.--Sample site descriptions--Continued

Site No.	Site name	Sample type	Remarks
			Utah--Continued
UT39	Oak Spring	W	Spring issues in marshy area on gentle slope. Two 5-cm-diameter pipes channel water into 0.8-m-square cement-walled tank. Sampled where pipes feed into tank.
UT40	Flowing well near Holden	W	Water pours out of wellhead beneath wooden cap few meters west of road. One of numerous flowing wells on valley floor in this area. Sampled at wellhead. Water used for irrigation.
UT41	Monroe Hot Springs	W S	Springs issue near base of hill. Spring several hundred meters north of swimming pool issues at top of extensive travertine apron about 10 m high. Sampled at point of issue at top of apron. Fresh travertine is forming along drainage.
UT42	Joseph Hot Springs	S	Springs issue over large area on east bank of river. Tested at one point of issue. Travertine shelf has formed around springs.
UT43	Thermo Hot Springs	W S	Springs issue along tops and sides of two low ridges on desert valley floor. Tested spring south of road on southeast flank of southern ridge. Travertine forms ridges.
UT44	Dixie Hot Springs	W S	Springs issue on north and south banks and in bed of river. Sampled at easternmost large spring in cave on south side of river. Travertine forms deposits around springs, and white precipitates are visible in river bed. Water used for swimming pool.
			Wyoming
WY 1	Taylor artesian well at Thermopolis	W S	Water flows from wellhead about 1 m above ground. Sampled at wellhead. Travertine forms irregular mound around well. H_2S smell.
WY 2	Ulcer spring at Thermopolis	W S	Spring issues at west base of RR cut on west bank of river 15 m south of foot bridge which crosses river from Thermopolis State Park on east bank. Sampled at point of issue. Some precipitate lines drainage.
WY 3	Big Spring at Thermopolis	W	Spring rises in 8-m-diameter pool with vigorous bubbling of large-volume flow at base of cliff. Sampled at edge of pool. Extensive travertine shelf has formed on east bank of river between hills and river. Travertine is still forming along drainages and at river edge. State Park.
WY 4	Wedding of the Waters spring	W S	Spring issues in irregular-shaped shallow pond east of road on east side of river at base of cliff. Point of issue not obvious. Sampled at edge of pond.
WY 5	Granite Creek Hot Spring	W S	Spring issues from crevices in rock. Sampled at point of issue before water flows into cement-lined pool. Water used for swimming. State Park.
WY 6	Astoria Mineral Hot Springs	W S	Springs issue on terrace at bend of river on south bank. Sampled at point of issue of one spring northeast of the northeast corner of swimming pool about 3 m above river level. Travertine is forming along drainage. Water used for swimming pool.
WY 7	Stinking Springs at Hoback Canyon	W	Springs issue on north and south sides of river at mouth of canyon. Sampled easternmost of three springs on south side of river. White precipitate coats drainages. H_2S smell.
WY 8	Washakie Mineral Hot Springs	W S	Spring issues in large pool about 50 m diameter. Point of issue not obvious. Sampled at outlet from pool. Travertine deposits are present around edges of pool. Water used for swimming.
WY 9	Auburn sulphur springs	W S	Springs issue in area about 10 by 30 m on north side of pond about 50 by 20 m across. Sampled at hottest point of issue at east side of spring area, apparently a well flowing at ground level. Numerous mounds of travertine and sulfurous precipitates up to 1.5 m high are forming around points of issue. Older travertine is visible around edges of pond. H_2S smell. Deposits have been mined for S.
WY10	Sulphur Springs at Doty Mountain (A, to north; B, to south)	W S	Springs issue in two 2- to 3-m-diameter pools, one on east side of road and one on west side of road about 100 m to south. Sampled at points of issue.

Table 2.--Analyses of water samples from 163 springs in the Western States

[Except as noted, Al, Ba, Be, B, Cr, Co, Cu, Ga, Ge, Fe, Mn, Mo, Ni, Sc, Ag, Sr, W, V, Yb, Y, and Zr were done by SPEC, and As, Cd, Pb, Li, Hg, Se, and Zn were done by AA. Except as noted, Ra values are for Ra-226 done by RN. Sb, Bi, and La, done by SPEC, were not detected in any samples. Sn, determined by SPEC, was detected in one sample and is discussed in footnote 23. Ratios of Ra and U to spc are shown as times 1,000. Footnotes are designated in column 2 and are shown at the end of the table. Abbreviations used in the table are shown below]

ymd	year, month, day
temp	temperature
fld	field measurement
spc	specific conductance in micromhos per centimeter
TDS	total dissolved solids in milligrams per liter
ROE	residue on evaporation
do	dissolved oxygen
lab alk	laboratory alkalinity
hard tot	total hardness
SPEC	emission spectrographic method for trace-element analysis
ICP	inductive coupled plasma method for trace-element analysis
WC	wet-chemical method for trace-element analysis
AA	atomic absorption method for trace-element analysis
RN	carrier-precipitation radon method for radium analysis
PLN	carrier-precipitation planchet method for radium analysis
C	degrees Celsius
ppm	parts per million
ppb	parts per billion
mv	millivolts
mg/L	milligrams per liter
ug/L	micrograms per liter
pCi/L	picocuries per liter
REF	radium enrichment factor: 2.95 x (Ra/U)
UEF	uranium enrichment factor: 0.339 x (U/Ra)
AZ	Arizona
CA	California
CO	Colorado
ID	Idaho
MT	Montana
NV	Nevada
NM	New Mexico
UT	Utah
WY	Wyoming

Table 2.--Analyses of water samples from 163 springs in the Western States

Sample	LATITUDE	LONGITUD	footnote	date ymd	temp C	pH fld	spc fld	TDS sum	TDS ROE	do ppm	Eh mv
AZ 1	36 29 57	111 51 26	--	760,429	18	8.2	340	--	--	--	--
AZ 3	36 28 37	111 50 42	--	760,429	18	8.0	360	--	--	--	--
AZ 5	36 20 47	112 43 29	--	760,507	20	8.3	2,130	--	--	--	--
AZ 6	36 20 44	112 40 15	--	760,507	19	8.3	1,350	--	--	--	--
AZ 9	36 15 43	112 55 3	--	760,508	17	8.1	1,830	--	--	--	--
AZ13	36 11 39	113 4 59	.1	760,509	26	7.4	1,340	--	--	--	--
AZ14	35 54 59	113 19 59	.1	760,511	25	6.7	11,900	--	--	--	--
AZ16	33 49 54	110 35 48	.1	760,207	21	7.3	40,000	34,200	--	--	--
AZ17	33 4 49	109 18 8	.1	760,206	56	7.5	18,000	10,500	--	--	--
AZ18	32 59 55	109 53 53	.2	760,206	44	8.2	5,000	--	--	--	--
CA 1	38 41 52	119 50 49	.3	790,709	60	7.7	1,800	1,340	--	1.80	-20
CA 2	38 32 27	119 23 37	.3	790,711	13	6.7	114	94	--	7.70	20
CA 3	38 24 16	119 23 36	.3	790,706	6	7.0	83	83	--	8.40	140
CA 4	38 21 3	119 23 58	10.4	770,510	59	6.7	2,600	1,750	2,270	1.00	-80
CA 5	38 14 46	119 12 13	11.5	770,511	69	6.9	4,600	3,390	3,850	.30	-100
CA 6	38 12 41	119 9 28	.3	790,705	15	7.5	360	189	--	5.90	80
CA 7	38 12 7	119 7 11	.3	790,705	24	8.0	140	129	--	5.90	80
CA 8	38 5 10	118 57 53	.3	790,701	12	9.5	780	494	--	.10	-300
CA 9	38 2 51	119 4 49	.3	790,703	66	7.7	1,850	1,200	--	1.10	-50
CA10	38 2 1	118 54 11	.3	790,702	30	6.8	3,000	2,060	--	.10	-170
CO 1	40 6 2	106 15 47	.1	760,621	28	7.7	2,650	1,560	--	--	--
CO 2	40 4 31	106 6 43	12.1	760,621	45	6.7	2,020	1,190	--	--	--
CO 3	39 33 40	107 19 16	13.0	760,921	50	6.4	35,000	19,900	--	--	--
CO 4	39 1 27	105 37 48	14.6	760,925	19	6.7	6,300	3,740	3,780	--	--
CO 5	39 1 5	105 47 38	15.0	760,925	57	7.0	3,800	2,190	2,240	--	--
CO 6	38 59 45	105 57 30	14.6	760,925	9	6.4	4,500	2,770	2,780	--	--
CO 7	38 57 11	105 56 37	14.6	760,925	10	6.9	26,400	27,200	27,400	--	--
CO 8	38 50 20	107 38 7	.1	750,521	41	6.6	3,200	2,010	3,120	--	--
CO 9	38 47 20	107 50 31	16.6	720,910	22	7.4	11,500	--	8,140	--	--
CO10	38 47 9	107 56 15	17.6	720,910	16	6.3	13,800	9,960	17,900	--	-240
CO11	38 46 21	107 46 9	18.6	740,830	13	6.3	3,300	2,440	3,440	--	-250
CO12A	38 46 11	107 45 30	19.7	730,912	15	6.5	5,000	3,190	3,420	--	-270
CO12B	38 46 11	107 45 32	19.7	730,912	14	2.9	2,600	2,130	2,120	--	90
CO14	38 44 17	105 31 47	20.7	800,624	8	6.3	7,500	4,840	4,620	--	40
CO15	38 36 8	105 32 58	20.7	800,624	12	6.3	12,000	9,940	9,780	--	-10
CO16	38 30 53	106 30 26	21.1	750,517	69	8.1	750	549	--	--	--
CO17	38 29 48	106 4 33	20.7	800,625	66	7.7	1,020	649	684	--	-50
CO19	38 10 5	105 55 4	22.6	750,516	59	6.9	1,000	649	672	--	--
CO21	38 8 40	107 44 1	23.4	770,623	52	6.8	2,900	2,730	--	--	--
CO22	38 1 7	107 40 26	24.0	750,519	60	6.5	1,950	1,680	1,930	--	-50
CO24	37 46 18	108 5 38	21.1	750,725	41	6.9	1,800	1,260	--	--	--
CO25	37 45 7	106 49 46	25.6	750,726	56	7.0	2,440	1,500	1,440	--	--
CO26	37 27 42	105 5 52	26.6	750,726	7	7.5	500	304	313	--	--
CO27	37 26 57	107 43 14	27.1	750,726	31	6.4	6,200	5,670	5,370	--	--
ID 1	43 38 34	111 41 16	.1	760,626	45	7.1	9,500	5,890	--	--	--

Table 2.--Analyses of water samples from 163 springs in the Western States

Sample	Ra pCi/L	Ra 228	U ug/L	Rn pCi/L	He ppb	REF	Ra/Spcon	UEF	U/spcon	SiO2 mgL	Ca mg/L
AZ 1	.15	--	.50	--	--	.89	.440	1.1000	1.5000	--	--
AZ 3	.17	--	.50	--	--	1.00	.470	1.0000	1.4000	--	--
AZ 5	.66	--	8.50	--	--	.23	.310	4.4000	4.0000	--	--
AZ 6	.36	--	6.40	--	--	.17	.270	6.0000	4.7000	--	--
AZ 9	.10	--	3.60	--	--	.08	.055	12.0000	2.0000	--	--
AZ13	.36	--	3.50	--	--	.30	.270	3.3000	2.6000	--	--
AZ14	23.00	--	7.10	--	--	9.60	1.900	.1000	.6000	--	--
AZ16	120.00	--	13.00	--	--	27.00	3.000	.0370	.3300	23.0	520.0
AZ17	14.00	--	.80	--	--	52.00	.780	.0190	.0440	8.0	930.0
AZ18	.62	--	1.00	530	--	2.40	.160	.4100	.2000	--	--
CA 1	7.10	--	.46	1,300	--	46.00	3.900	.0220	.2600	93.0	33.0
CA 2	.16	--	.50	1,300	--	.94	1.400	1.1000	4.4000	32.0	7.8
CA 3	.05	--	.20	2,700	--	.74	.600	1.4000	2.4000	38.0	5.7
CA 4	15.00	--	2.20	760	-780	20.00	5.800	.0500	.8500	110.0	41.0
CA 5	2.30	--	.64	130	--	11.00	.500	.0940	.1400	88.0	74.0
CA 6	.12	--	2.10	440	--	.17	.330	5.9000	5.8000	72.0	14.0
CA 7	.01	--	1.00	960	--	.03	.071	34.0000	7.1000	55.0	9.9
CA 8	.12	--	.08	180	--	4.40	.150	.2300	.1000	40.0	1.0
CA 9	.13	--	.02	160	--	19.00	.070	.0520	.0110	77.0	14.0
CA10	.69	--	.27	450	--	9.70	.300	.1000	.0900	120.0	49.0
CO 1	16.00	--	.06	--	--	790.00	6.000	.0013	.0230	25.0	13.0
CO 2	3.30	--	<.01	510	--	>970.00	1.600	<.0010	<.0050	33.0	15.0
CO 3	24.00	--	.07	300	--	1,000.00	.690	.0010	.0020	30.0	450.0
CO 4	2.60	--	.30	--	--	26.00	.410	.0390	.0480	16.0	56.0
CO 5	5.10	--	.20	--	--	75.00	1.300	.0130	.0530	39.0	113.0
CC 6	.20	--	1.90	--	--	.31	.044	3.2000	.4200	14.0	57.0
CO 7	2.40	--	.20	--	--	35.00	.091	.0280	.0076	12.0	847.0
CO 8	9.10	--	.03	--	--	890.00	2.800	.0011	.0094	25.0	110.0
CO 9	9.00	--	3.10	56	--	8.60	.780	.1200	.2700	10.0	140.0
CO10	2.60	--	16.00	210	1,500	.48	.190	2.1000	1.2000	17.0	230.0
CO11	.55	--	.45	<10	--	3.60	.170	.2800	.1400	38.0	98.0
CO12A	2.90	--	.59	1,300	-740	15.00	.580	.0690	.1200	17.0	110.0
CO12B	1.50	--	4.50	110	1,200	.98	.580	1.0000	1.7000	60.0	170.0
CO14	18.00	--	57.00	960	70	.93	2.400	1.1000	7.6000	67.0	110.0
CO15	300.00	--	110.00	10,000	-1,300	8.00	25.000	.1200	9.2000	67.0	45.0
CO16	.08	--	.23	140	--	1.00	.110	.9700	.3100	77.0	8.6
CO17	.75	--	.04	5,200	-700	55.00	.740	.0180	.0390	75.0	18.0
CC19	6.40	--	<.40	2,100	--	>47.00	6.400	<.0210	<.4100	46.0	58.0
CO21	3.30	--	.13	300	--	75.00	1.100	.0130	.0450	54.0	290.0
CO22	5.10	--	.03	2,500	1,100	500.00	3.600	.0020	.0210	49.0	380.0
CO24	1.50	--	.45	--	--	9.80	.810	.1000	.2400	34.0	330.0
CO25	4.60	--	<.40	72	--	>34.00	2.100	<.0300	<.1800	86.0	65.0
CO26	2.70	--	.01	--	--	800.00	5.400	.0013	.0200	6.0	33.0
CO27	28.00	--	2.40	--	--	34.00	4.700	.0290	.4000	64.0	350.0
ID 1	28.00	--	.04	--	--	2,100.00	2.900	.0005	.0042	29.0	450.0

Table 2.--Analyses of water samples from 163 springs in the Western States

Sample	Mg mg/L	Na mg/L	K mg/L	HCO3 mgL	CO3 mg/L	SO4 mg/L	Cl mg/L	F mg/L	NO2+NO3	orthoPO4	lab alk
AZ 1	--	--	--	--	--	--	--	--	--	--	--
AZ 3	--	--	--	--	--	--	--	--	--	--	--
AZ 5	--	--	--	--	--	--	--	--	--	--	--
AZ 6	--	--	--	--	--	--	--	--	--	--	--
AZ 9	--	--	--	--	--	--	--	--	--	--	--
AZ13	--	--	--	--	--	--	--	--	--	--	--
AZ14	--	--	--	--	--	--	--	--	--	--	--
AZ16	220.0	12,000.0	260.0	1,960	<1	1,100.0	19,000.0	2.8	.01	.77	1,610
AZ17	24.0	3,000.0	21.0	136	<1	43.0	6,400.0	2.2	.31	.12	112
AZ18	--	--	--	--	--	--	--	--	--	--	--
CA 1	1.9	430.0	13.0	756	<1	200.0	190.0	4.2	<.01	--	620
CA 2	2.7	10.0	.9	46	<1	13.0	3.3	.2	.37	--	38
CA 3	1.5	4.9	3.0	34	<1	6.6	.7	.1	1.30	--	28
CA 4	11.0	570.0	39.0	1,110	<1	270.0	160.0	5.7	<.01	.34	910
CA 5	18.0	1,100.0	55.0	1,760	<1	970.0	210.0	5.6	.01	.55	1,440
CA 6	6.1	17.0	7.8	101	<1	16.0	3.3	.2	.71	--	83
CA 7	1.1	16.0	2.8	57	<1	11.0	2.2	.1	.67	--	47
CA 8	.2	160.0	15.0	286	43	80.0	12.0	.8	.67	--	270
CA 9	3.0	420.0	8.9	427	<1	130.0	330.0	4.7	.03	--	350
CA10	53.0	650.0	56.0	1,620	<1	90.0	220.0	1.2	3.10	--	1,330
CO 1	4.0	590.0	15.0	878	107	96.0	250.0	12.0	<.01	.21	915
CO 2	3.5	430.0	21.0	808	<1	130.0	150.0	12.0	<.01	<.01	663
CO 3	69.0	6,800.0	170.0	706	<1	1,000.0	11,000.0	1.3	.01	.18	579
CO 4	27.0	1,410.0	62.0	1,220	<1	42.0	1,180.0	8.0	<.10	<.01	--
CO 5	19.0	654.0	32.0	295	<1	300.0	818.0	1.9	<.10	<.01	--
CO 6	19.0	940.0	18.0	149	<1	284.0	1,280.0	.2	.90	<.01	--
CO 7	182.0	9,000.0	128.0	203	<1	1,990.0	14,900.0	.3	<.10	<.01	--
CO 8	34.0	610.0	36.0	1,540	<1	58.0	370.0	2.4	.01	.12	1,260
CO 9	95.0	2,700.0	71.0	3,730	<1	870.0	1,800.0	2.2	--	--	3,060
CO10	240.0	3,100.0	81.0	1,750	217	2,800.0	2,400.0	.9	<.10	.11	--
CO11	140.0	560.0	28.0	1,290	<1	620.0	320.0	1.6	<.01	.25	1,060
CO12A	43.0	1,100.0	47.0	2,150	<1	94.0	720.0	2.5	.01	.12	1,760
CO12B	98.0	180.0	22.0	<1	<1	1,500.0	25.0	.7	.48	.18	<1
CO14	96.0	1,600.0	71.0	2,930	<1	134.0	1,330.0	1.9	<.10	<.01	--
CO15	125.0	3,650.0	200.0	4,330	<1	113.0	3,930.0	2.3	.20	<.01	--
CO16	.4	160.0	10.0	165	<1	180.0	16.0	15.0	<.01	.01	135
CO17	.6	198.0	8.0	189	<1	188.0	47.0	10.0	<.10	<.01	--
CO19	13.0	146.0	13.0	323	<1	159.0	38.0	4.3	<.10	<.01	--
CO21	18.0	440.0	28.0	410	<1	1,200.0	88.0	3.6	.02	.01	340
CO22	9.0	120.0	10.0	129	<1	1,000.0	43.0	3.1	<.01	.03	106
CO24	45.0	35.0	19.0	877	<1	350.0	6.6	.6	.06	.03	719
CO25	14.0	462.0	46.0	976	<1	165.0	231.0	8.0	<.10	<.01	853
CO26	4.5	75.0	1.9	287	<1	42.0	9.5	.5	<.10	<.01	--
CO27	54.0	830.0	71.0	162	<1	720.0	1,500.0	2.7	.01	.06	133
ID 1	82.0	1,500.0	190.0	1,080	<1	700.0	2,400.0	3.5	<.01	.25	836

Table 2.--Analyses of water samples from 163 springs in the Western States

Sample	hard tot	Al ug/L	As ug/L	Ba ug/L	Be ug/L	B ug/L	Cd ug/L	Cr ug/L	Co ug/L	Cu ug/L
AZ 1	--	--	--	--	--	--	--	--	--	--
AZ 3	--	--	--	--	--	--	--	--	--	--
AZ 5	--	--	--	--	--	--	--	--	--	--
AZ 6	--	--	--	--	--	--	--	--	--	--
AZ 9	--	--	--	--	--	--	--	--	--	--
AZ13	--	20	--	200.00	<5.00	550.0	<1	<20.00	<20.00	<5.00
AZ14	--	210	--	100.00	<30.00	12,000.0	<1	<130.00	<130.00	<30.00
AZ16	2,200	<250	--	<200.00	<100.00	23,000.0	<1	<300.00	<500.00	<100.00
AZ17	2,400	<80	--	1,300.00	<40.00	1,100.0	1	<100.00	<160.00	<35.00
AZ18	--	--	--	--	--	--	--	--	--	--
CA 1	90	<50	420	100.00	<1.00	3,000.0	--	--	--	--
CA 2	31	300	1	10.00	<1.00	<5.0	--	--	--	--
CA 3	20	100	<1	50.00	<1.00	<5.0	--	--	--	--
CA 4	150	10	1,000	95.00	4.50	>2,300.0	--	<2.30	3.40	<5.00
CA 5	260	10	--	54.00	3.90	>3,900.0	--	<3.90	4.20	9.60
CA 6	60	100	2	10.00	<1.00	30.0	--	--	--	--
CA 7	29	100	2	5.00	<1.00	<5.0	--	--	--	--
CA 8	3	<50	64	5.00	<1.00	700.0	--	--	--	--
CA 9	47	<50	1	10.00	<1.00	5,000.0	--	--	--	--
CA10	360	300	81	100.00	<1.00	5,000.0	--	--	--	--
CO 1	49	50	--	300.00	<10.00	400.0	<1	<35.00	<35.00	<7.00
CO 2	52	20	5	100.00	<10.00	360.0	<1	<25.00	<25.00	2.00
CO 3	1,500	20	<1	100.00	20.00	860.0	<1	10.00	<1.00	<1.00
CO 4	253	110	--	480.00	12.00	1,800.0	--	<4.00	<2.00	<.20
CO 5	362	22	2	64.00	<2.00	450.0	1	<4.00	<2.00	<2.00
CO 6	221	22	--	12.00	<2.00	150.0	--	<4.00	<2.00	<2.00
CO 7	2,830	75	--	40.00	<2.00	460.0	--	<4.00	<2.00	<2.00
CO 8	410	55	--	4,000.00	<5.00	800.0	<1	<15.00	<15.00	<3.00
CO 9	--	380	460	<250.00	26.00	3,200.0	--	<3.00	<5.00	10.00
CO10	1,600	1,200	150	<19.00	<2.00	5,900.0	--	<3.00	<5.00	27.00
CO11	820	20	--	17.00	<6.00	770.0	--	<8.00	<16.00	<4.00
CO12A	450	75	3	3,500.00	2.00	5,300.0	--	<1.00	<3.00	<10.00
CO12B	830	10,000	4	37.00	12.00	330.0	--	26.00	<22.00	40.00
CO14	673	26	2	55.00	7.00	780.0	--	<1.00	<2.00	<20.00
CO15	630	60	140	99.00	22.00	6,300.0	--	<1.00	<2.00	<20.00
CO16	23	85	<1	94.00	<1.00	60.0	<1	<4.00	<4.00	1.00
CO17	48	18	3	88.00	.40	44.0	--	<2.00	<1.00	<10.00
CO19	199	14	28	100.00	<.20	200.0	<1	<2.00	<1.00	<10.00
CO21	--	20	240	35.00	<1.90	380.0	1	<2.70	<2.70	11.00
CO22	990	80	13	46.00	<2.00	180.0	<1	<9.00	<2.00	2.00
CO24	1,000	40	5	55.00	<2.00	90.0	<1	<9.00	<9.00	<2.00
CO25	222	13	21	130.00	2.00	2,100.0	<1	<2.00	<1.00	<10.00
CO26	102	16	--	100.00	.10	53.0	--	<1.00	<2.00	<46.00
CO27	1,100	100	--	45.00	<6.00	2,000.0	<1	<25.00	<25.00	7.00
ID 1	1,500	80	--	50.00	<30.00	2,800.0	<1	<100.00	<100.00	<20.00

Table 2.--Analyses of water samples from 163 springs in the western States

Sample	Ga ug/L	Ge ug/L	Fe ug/L	Pb ug/L	Li ug/L	Mn ug/L	Hg ug/L	Mo ug/L	Na ug/L	Ni ug/L
AZ 1	--	--	--	--	--	--	--	--	--	--
AZ 3	--	--	--	--	--	--	--	--	--	--
AZ 5	--	--	--	--	--	--	--	--	--	--
AZ 6	--	--	--	--	--	--	--	--	--	--
AZ 9	--	--	--	--	--	--	--	--	--	--
AZ13	<10.00	<40.00	20	<20.0	230	<20.0	--	<10.0	--	<20.00
AZ14	<60.00	<250.00	1,200	<140.0	3,000	210.0	--	<60.0	--	<130.00
AZ16	<250.00	<500.00	11,000	<500.0	14,000	700.0	--	760.0	--	<500.00
AZ17	<60.00	<160.00	<160	<160.0	5,200	1,400.0	--	250.0	--	<160.00
AZ18	--	--	--	--	--	--	--	--	--	--
CA 1	--	--	40	23.0	1,000	80.0	<.1	30.0	--	--
CA 2	--	--	40	<1.0	<10	2.0	<.1	<10.0	--	--
CA 3	--	--	30	15.0	<10	<1.0	<.1	<10.0	--	--
CA 4	<5.00	<10.00	90	17.0	3,600	360.0	<.1	57.0	--	<10.00
CA 5	<8.50	<18.00	160	<39.0	6,500	58.0	--	16.0	--	<18.00
CA 6	--	--	<10	3.0	10	<1.0	<.1	<10.0	--	--
CA 7	--	--	<10	13.0	10	<1.0	<.1	<10.0	--	--
CA 8	--	--	10	<1.0	100	2.0	.3	<10.0	--	--
CA 9	--	--	10	<1.0	300	20.0	<.1	<10.0	--	--
CA10	--	--	170	<1.0	700	120.0	<.1	<10.0	--	--
CO 1	<20.00	<70.00	110	<45.0	740	70.0	--	10.0	--	<35.00
CO 2	<10.00	<50.00	60	<35.0	1,100	50.0	<.1	<10.0	--	<25.00
CO 3	<50.00	<100.00	40	<1.0	820	70.0	<.1	<1.0	--	<1.00
CO 4	<27.00	<35.00	440	.4	920	130.0	--	.5	--	<1.00
CO 5	<17.00	<20.00	80	.5	540	130.0	<.1	1.0	--	<1.00
CO 6	<20.00	<25.00	15	.2	25	15.0	--	3.0	--	<1.00
CO 7	<170.00	<200.00	530	<2.0	150	160.0	--	<.4	--	1.00
CO 8	<7.00	<15.00	<15	<15.0	1,500	700.0	--	<3.0	--	<15.00
CO 9	<55.00	<120.00	200	1.0	6,400	860.0	--	5.0	--	<11.00
CO10	<120.00	<250.00	750	3.0	10,000	320.0	<.1	20.0	--	<11.00
CO11	<4.00	<16.00	590	<16.0	2,000	860.0	--	<6.0	--	<6.00
CO12A	<22.00	<50.00	<10	13.0	3,400	660.0	<.1	<.5	--	<5.00
CO12B	<14.00	<30.00	47,000	21.0	190	1,200.0	<.1	.7	--	15.00
CO14	<34.00	<46.00	340	<1.0	1,700	<1.0	<.1	2.0	--	7.00
CO15	<67.00	<69.00	1,700	2.0	8,600	<1.0	<.1	2.0	--	8.00
CO16	6.00	<5.00	10	<4.0	200	30.0	<.1	--	--	<4.00
CO17	<6.00	<26.00	20	2.0	80	70.0	<.1	34.0	--	<2.00
CO19	<6.00	<27.00	22	1.0	280	20.0	<.1	14.0	--	<2.00
CO21	<6.00	<13.00	1,100	<10.0	3,000	160.0	<.1	9.3	<130.0	<13.00
CO22	<4.00	<9.00	170	7.0	730	1,000.0	<.1	30.0	--	<9.00
CO24	<4.00	<9.00	2,300	<9.0	100	1,800.0	<.1	--	--	<9.00
CO25	<14.00	<22.00	240	<.8	1,900	310.0	<.1	<.5	--	8.00
CO26	<3.00	<4.00	12	<1.0	46	98.0	--	<.5	--	<5.00
CO27	<12.00	<25.00	4,800	<25.0	2,800	600.0	--	53.0	--	<25.00
ID 1	<40.00	<200.00	170	<150.0	2,500	240.0	--	40.0	--	<100.00

Table 2.--Analyses of water samples from 163 springs in the Western States

Sample	Sc ug/L	Se ug/L	Ag ug/L	Sr ug/L	W ug/L	V ug/L	Yb ug/L	Y ug/L	Zn ug/L	Zr ug/L
AZ 1	--	--	--	--	--	--	--	--	--	--
AZ 3	--	--	--	--	--	--	--	--	--	--
AZ 5	--	--	--	--	--	--	--	--	--	--
AZ 6	--	--	--	--	--	--	--	--	--	--
AZ 9	--	--	--	--	--	--	--	--	--	--
AZ13	--	--	<2.00	390.0	--	<10.0	--	--	<10.0	<30.00
AZ14	--	--	<15.00	10,000.0	--	<60.0	--	--	10.0	<200.00
AZ16	--	--	<25.00	12,000.0	--	<250.0	--	--	700.0	<1,000.00
AZ17	--	--	<16.00	30,000.0	--	<100.0	--	--	30.0	<300.00
AZ18	--	--	--	--	--	--	--	--	--	--
CA 1	--	<1	--	3,000.0	--	--	--	--	<5.0	--
CA 2	--	<1	--	100.0	--	--	--	--	30.0	--
CA 3	--	<1	--	100.0	--	--	--	--	<5.0	--
CA 4	<2.30	<1	<.23	2,000.0	<23.0	<7.3	.340	4.10	<50.0	<10.00
CA 5	<3.90	--	<.39	5,800.0	<180.0	<12.0	<.390	<5.80	<85.0	<18.00
CA 6	--	<1	--	100.0	--	--	--	--	<5.0	--
CA 7	--	<1	--	30.0	--	--	--	--	<5.0	--
CA 8	--	<1	--	7.0	--	--	--	--	<5.0	--
CA 9	--	<1	--	100.0	--	--	--	--	<5.0	--
CA10	--	<1	--	500.0	--	--	--	--	<5.0	--
CO 1	--	--	<5.00	720.0	--	<20.0	--	--	20.0	<70.00
CO 2	--	<1	<4.00	700.0	--	<20.0	--	--	<10.0	<50.00
CO 3	--	<1	<1.00	6,400.0	--	<50.0	--	--	40.0	<200.00
CO 4	--	--	1.00	2,300.0	--	<25.0	<4.000	<.40	<46.0	<2.00
CO 5	--	<1	.90	1,100.0	--	<14.0	<4.000	<.40	10.0	<2.00
CO 6	--	--	.90	1,200.0	--	<16.0	<4.000	<.40	<46.0	<2.00
CO 7	--	--	.70	31,000.0	--	<150.0	<4.000	<.40	<46.0	<2.00
CO 8	--	--	<2.00	3,100.0	--	<10.0	--	--	<10.0	<20.00
CO 9	--	--	<2.00	4,300.0	--	<55.0	<1.000	18.00	<100.0	<5.00
CO10	--	<1	<2.00	2,800.0	--	<120.0	<1.000	<11.00	<200.0	22.00
CO11	--	--	<2.00	1,100.0	--	<8.0	--	--	<20.0	<16.00
CO12A	--	<1	<.30	3,600.0	--	<20.0	<.300	<3.00	<22.0	<1.00
CO12B	--	<1	<.30	900.0	--	<13.0	.300	20.00	570.0	12.00
CO14	--	<1	<.20	6,900.0	--	<85.0	<.200	<2.00	<46.0	5.00
CO15	--	<1	<.20	2,800.0	--	<170.0	<.200	<2.00	<46.0	57.00
CO16	--	<1	<1.00	290.0	--	<4.0	--	--	<10.0	<7.00
CO17	--	<1	<.10	540.0	--	<12.0	<1.000	<1.00	<10.0	<2.00
CO19	--	<1	<.10	950.0	--	<12.0	<1.000	<1.00	<10.0	<2.00
CO21	3.60	<1	<.27	8,200.0	<130.0	<8.7	<.270	<4.10	10.0	27.00
CO22	--	<1	<1.00	6,100.0	--	<9.0	--	--	10.0	<15.00
CO24	--	<1	<1.00	3,000.0	--	<9.0	--	--	<10.0	<10.00
CO25	--	<1	<.10	2,000.0	--	<11.0	<1.000	<1.00	<10.0	<2.00
CO26	--	--	<.20	360.0	--	<7.0	<.200	<2.00	<22.0	<1.00
CO27	--	--	<3.00	4,900.0	--	<25.0	--	--	30.0	<40.00
ID 1	--	--	<15.00	5,000.0	--	<65.0	--	--	10.0	<200.00

Table 2.--Analyses of water samples from 163 springs in the Western States--continued

Sample	LATITUDE	LONGITUD	footnote	date ymd	temp C	pH fld	spc fld	TDS sum	TDS ROE	do ppm	Eh mv
ID 2	43 25 24	111 24 50	.1	760,628	17	6.5	4,350	2,560	--	--	--
ID 3	42 39 25	111 36 16	.1	760,629	30	7.0	4,100	2,310	--	--	--
ID 4	42 37 11	112 0 19	--	760,629	42	6.8	1,430	--	--	--	--
ID 5	42 9 18	112 20 53	--	760,630	24	7.3	2,200	--	--	--	--
ID 6	0 0 0B	0 0 0B	28.1	--	75	7.2	3,150	1,900	--	--	--
MT 1	46 35 36	112 6 52	.3	780,818	60	9.4	1,060	640	--	--	-130
MT 2	46 32 50	110 54 10	.3	780,820	48	6.9	2,360	1,470	--	--	-140
MT 3	46 26 51	111 58 57	.3	780,816	54	6.6	1,360	970	--	--	--
MT 4	46 26 48	111 59 14	.3	780,817	28	6.3	1,510	1,060	--	--	-120
MT 5	46 11 55	112 5 42	.3	780,818	73	8.4	560	417	--	--	-340
MT 6	46 10 40	112 47 42	.3	780,819	77	7.0	1,510	1,230	--	--	-170
MT 7	46 2 33	112 48 37	.3	780,819	65	8.5	860	574	--	--	-175
MT 8	45 53 48	112 13 59	.3	780,819	60	8.9	480	376	--	--	-240
MT 9	45 41 7	112 17 29	.3	780,821	69	8.0	900	649	--	--	90
MT10	45 34 28	111 41 40	.3	780,820	43	7.8	960	668	--	--	--
MT11	45 27 43	112 26 27	.3	780,821	52	6.7	2,250	1,730	--	--	-120
MT12	45 27 34	113 6 19	.3	780,821	45	9.2	230	182	--	--	100
MT13	45 22 3	113 24 11	.3	780,822	58	7.0	1,040	670	--	--	100
MT14	45 5 24	110 46 24	.3	780,815	63	6.9	2,600	2,050	--	--	95
NV 1	41 55 28	118 42 33	.5	770,507	88	7.9	965	679	852	--	--
NV 2	41 47 26	119 6 24	.5	770,507	22	7.9	130	128	163	8.00	--
NV 3	41 43 16	118 30 17	.5	770,507	54	8.7	420	306	412	--	--
NV 5	41 9 43	114 59 5	29.5	770,518	35	6.6	1,730	1,190	1,650	1.00	-560
NV 6A	40 57 44	117 29 28	30.4	770,505	60	7.0	870	577	858	--	-60
NV 6B	40 57 41	117 29 35	.4	770,505	33	--	850	--	--	11.00	--
NV 7	40 50 34	117 11 59	.4	770,505	15	7.0	740	--	--	3.40	--
NV 8	40 49 44	117 18 19	.5	770,505	34	7.1	1,020	660	965	--	--
NV 9	40 39 41	119 21 57	.5	770,508	92	8.0	7,300	4,460	4,910	--	--
NV10	40 35 12	115 17 5	.5	770,517	93	8.4	630	504	752	--	--
NV11	40 33 41	116 35 22	.5	770,504	90	9.4	1,170	1,100	1,450	--	--
NV12	40 24 24	117 53 40	.5	770,508	66	6.9	3,500	1,950	2,510	--	--
NV13	40 24 6	116 31 5	.4	770,504	27	--	570	--	--	--	--
NV14	40 22 4	117 19 32	.5	770,506	66	7.1	1,480	989	1,480	--	--
NV15	40 5 14	117 43 29	.4	770,506	51	7.8	1,430	--	--	--	--
NV16	40 5 8	114 38 40	.3	780,824	10	8.6	360	176	--	--	260
NV17	39 46 37	114 50 59	.3	780,825	18	7.8	430	198	--	--	270
NV18	39 40 1	114 48 26	31.0	770,516	78	6.7	560	339	542	.50	-110
NV19	39 33 27	116 21 32	.5	770,515	42	7.5	600	370	496	.40	--
NV20	39 32 20	114 54 54	.3	780,825	24	7.3	470	252	--	--	270
NV21	39 24 45	114 46 42	.3	780,824	18	7.3	650	401	--	--	130
NV22	39 19 30	116 50 56	.5	770,514	72	7.6	1,210	859	1,190	.60	--
NV23	39 16 58	114 51 56	.3	780,825	34	7.3	500	294	--	--	250
NV24	38 55 8	118 11 44	.3	790,628	54	8.0	1,350	1,030	--	4.70	-30
NV25A	38 53 59	119 24 39	.4	770,510	63	9.0	540	--	--	.20	--
NV25B	38 53 57	119 24 39	32.5	770,510	61	9.0	520	355	425	.40	-10

Table 2.--Analyses of water samples from 163 springs in the Western States--continued

Sample	Ra pCi/L	Ra 228	U ug/L	Rn pCi/L	He ppo	REF	Ra/Spcon	UEF	U/spcon	SiO2 mgL	Ca mg/L
ID 2	2.30	--	.20	--	--	34.00	.530	.0300	.0460	10.0	270.0
ID 3	1.40	--	.01	--	--	410.00	.340	.0024	.0024	29.0	880.0
ID 4	.71	--	.30	--	--	7.00	.500	.1400	.2100	--	--
ID 5	.53	--	.40	--	--	3.90	.240	.2600	.1800	--	--
ID 6	8.00	--	.05	--	--	470.00	2.500	.0021	.0160	55.0	89.0
MT 1	.15	<1.6	<.01	1,100	--	>44.00	.140	<.0230	<.0094	1.3	2.0
MT 2	2.20	2.5	.02	620	--	320.00	.930	.0031	.0085	48.0	41.0
MT 3	25.00	18.0	.50	25,000	--	150.00	18.000	.0068	.3700	70.0	27.0
MT 4	43.00	12.0	.60	41,000	--	210.00	28.000	.0047	.4000	73.0	29.0
MT 5	.18	<1.6	<.01	3,600	--	>53.00	.320	<.0190	<.0180	100.0	3.0
MT 6	17.00	11.0	<.01	390	--	>5,000.00	11.000	<.0002	<.0066	53.0	220.0
MT 7	.06	<1.7	<.01	560	--	>18.00	.070	<.0570	<.0120	86.0	4.0
MT 8	.05	<1.7	<.01	650	--	>15.00	.100	<.0680	<.0210	70.0	3.0
MT 9	.14	<1.8	<.01	120	--	>41.00	.160	<.0240	<.0110	110.0	9.0
MT10	1.00	2.4	.02	600	--	150.00	1.000	.0068	.0210	89.0	19.0
MT11	27.00	<2.0	.01	13,000	--	8,000.00	12.000	.0001	.0044	44.0	300.0
MT12	.05	<1.5	.02	950	--	7.40	.220	.1400	.0870	52.0	2.0
MT13	3.70	5.7	<.01	630	--	>1,100.00	3.600	<.0009	<.0096	47.0	11.0
MT14	8.50	3.5	.15	510	--	170.00	3.300	.0060	.0580	46.0	330.0
NV 1	.20	--	<.01	--	--	>59.00	.210	<.0170	<.0100	120.0	10.0
NV 2	<.10	--	.90	--	--	<.33	<.770	>3.1000	6.9000	53.0	3.6
NV 3	<.10	--	<.01	--	--	--	<.240	--	<.0240	80.0	1.9
NV 5	14.00	--	.13	1,200	--	320.00	8.100	.0031	.0750	71.0	54.0
NV 6A	3.80	--	.03	310	51	370.00	4.400	.0027	.0350	57.0	36.0
NV 6B	13.00	--	.11	--	--	350.00	15.000	.0029	.1300	--	--
NV 7	.40	--	.16	--	--	7.40	.540	.1400	.2200	--	--
NV 8	.20	--	1.20	--	--	.49	.200	2.0000	1.2000	35.0	59.0
NV 9	2.30	--	<.01	--	--	>630.00	.320	<.0015	<.0014	160.0	72.0
NV10	<.10	--	<.01	--	--	--	<.160	--	<.0160	150.0	1.0
NV11	.10	--	<.01	--	--	>30.00	.086	<.0340	<.0085	270.0	.8
NV12	8.40	--	<.01	--	--	>2,500.00	2.400	<.0004	<.0029	110.0	95.0
NV13	<.10	--	3.60	--	--	<.08	<.180	>12.0000	6.3000	--	--
NV14	7.10	--	<.01	--	--	>2,100.00	4.800	<.0005	<.0068	74.0	48.0
NV15	3.10	--	<.01	--	--	>910.00	2.200	<.0011	<.0070	--	--
NV16	.55	<1.5	1.70	670	--	.95	1.500	1.0000	4.7000	16.0	30.0
NV17	.34	<1.3	1.80	91	--	.56	.790	1.8000	4.2000	11.0	49.0
NV18	110.00	33.0	<.01	4,300	1,300	>32,000.00	200.000	<.0001	<.0180	49.0	69.0
NV19	12.00	--	.04	--	--	890.00	20.000	.0011	.0670	28.0	62.0
NV20	.32	<1.3	1.70	230	--	.56	.680	1.8000	3.6000	19.0	51.0
NV21	.09	<1.4	1.70	<10	--	.16	.140	6.4000	2.6000	19.0	73.0
NV22	5.00	--	.04	--	--	410.00	4.600	.0024	.0330	150.0	46.0
NV23	5.40	<1.4	2.70	62	--	5.90	11.000	.1700	5.4000	23.0	55.0
NV24	.87	--	.02	300	--	130.00	.640	.0078	.0150	160.0	14.0
NV25A	<.10	--	.18	--	--	<1.60	<.190	>.6100	.3300	--	--
NV25B	<.10	--	.62	2,000	--	<.48	<.190	>2.1000	1.2000	53.0	4.5

Table 2.--Analyses of water samples from 163 springs in the Western States--continued

Sample	Mg mg/L	Na mg/L	K mg/L	HCO3 mgL	CO3 mg/L	SO4 mg/L	Cl mg/L	F mg/L	NO2+NO3	orthoPO4	lab alk
ID 2	61.0	570.0	65.0	955	<1	160.0	950.0	.9	<.01	.12	783
ID 3	160.0	13.0	23.0	803	<1	800.0	5.9	.5	<.01	.21	659
ID 4	--	--	--	--	--	--	--	--	--	--	--
ID 5	--	--	--	--	--	--	--	--	--	--	--
ID 6	24.0	490.0	110.0	491	<1	260.0	630.0	1.1	.07	.04	403
MT 1	<.1	230.0	10.0	120	18	260.0	47.0	12.0	.01	--	130
MT 2	11.0	430.0	22.0	790	<1	300.0	170.0	7.1	.01	--	650
MT 3	4.7	320.0	16.0	700	<1	160.0	19.0	7.9	.01	--	570
MT 4	5.3	350.0	19.0	770	<1	170.0	23.0	8.3	<.01	--	630
MT 5	<.1	120.0	3.8	140	12	78.0	20.0	11.0	.01	--	130
MT 6	23.0	120.0	23.0	250	<1	660.0	5.1	3.6	.01	--	210
MT 7	<.1	180.0	4.1	140	8	190.0	16.0	17.0	.01	--	130
MT 8	<.1	110.0	1.9	68	18	110.0	24.0	5.3	.01	--	86
MT 9	.2	190.0	7.0	170	<1	200.0	40.0	8.5	.01	--	140
MT10	3.0	200.0	11.0	370	<1	130.0	26.0	7.2	.01	--	300
MT11	71.0	160.0	24.0	220	<1	970.0	52.0	2.6	<.01	--	180
MT12	.1	46.0	.8	60	14	34.0	1.8	2.0	<.01	--	73
MT13	3.5	240.0	11.0	610	<1	47.0	9.2	.4	.01	--	500
MT14	62.0	210.0	24.0	260	<1	1,200.0	43.0	3.2	.05	--	210
NV 1	.1	190.0	8.5	150	<1	220.0	49.0	7.1	.06	.15	120
NV 2	.3	22.0	3.8	50	<1	10.0	5.0	.6	1.10	.18	41
NV 3	<.1	94.0	1.7	110	19	32.0	14.0	8.9	.01	.06	120
NV 5	13.0	380.0	39.0	1,120	<1	32.0	36.0	7.6	.01	.09	920
NV 6A	7.6	150.0	23.0	440	<1	60.0	23.0	2.3	.12	.06	360
NV 6B	--	--	--	--	--	--	--	--	--	--	--
NV 7	--	--	--	--	--	--	--	--	--	--	--
NV 8	17.0	160.0	14.0	500	<1	91.0	36.0	1.7	.01	.06	410
NV 9	1.2	1,500.0	110.0	85	<1	370.0	2,200.0	5.5	.01	.15	70
NV10	.1	140.0	9.2	210	13	41.0	29.0	17.0	<.01	.12	190
NV11	.1	270.0	27.0	220	200	140.0	65.0	14.0	.31	.15	510
NV12	22.0	540.0	82.0	490	<1	66.0	790.0	5.7	.15	.15	400
NV13	--	--	--	--	--	--	--	--	--	--	--
NV14	4.6	290.0	34.0	820	<1	100.0	28.0	5.5	.04	.09	670
NV15	--	--	--	--	--	--	--	--	--	--	--
NV16	16.0	9.0	2.9	140	7	20.0	6.1	.2	.02	--	130
NV17	21.0	4.8	1.0	180	<1	17.0	4.0	.1	.41	--	150
NV18	19.0	16.0	5.6	310	<1	23.0	3.2	1.1	.01	.03	250
NV19	18.0	42.0	12.0	340	<1	30.0	8.9	1.2	<.01	.03	280
NV20	21.0	9.3	3.4	250	<1	18.0	4.4	.4	.57	--	210
NV21	27.0	18.0	4.1	200	<1	140.0	17.0	.2	.92	--	160
NV22	9.9	210.0	36.0	670	<1	48.0	23.0	6.0	<.01	.09	550
NV23	23.0	13.0	3.2	210	<1	64.0	8.9	.5	.07	--	170
NV24	.2	280.0	11.0	207	<1	370.0	84.0	12.0	.01	--	170
NV25A	--	--	--	--	--	--	--	--	--	--	--
NV25B	<.1	99.0	2.2	42	18	140.0	14.0	3.6	.02	.06	64

Table 2.--Analyses of water samples from 163 springs in the Western States--continued

Sample	hard tot	Al ug/L	As ug/L	Ba ug/L	Be ug/L	B ug/L	Cd ug/L	Cr ug/L	Co ug/L	Cu ug/L
ID 2	930	20	--	80.00	<20.00	850.0	<1	<50.00	<50.00	<10.00
ID 3	2,900	70	--	40.00	<20.00	90.0	<1	<60.00	<60.00	<15.00
ID 4	--	--	--	--	--	--	--	--	--	--
ID 5	--	--	--	--	--	--	--	--	--	--
ID 6	320	20	--	80.00	<10.00	1,000.0	<1	<35.00	<35.00	<10.00
MT 1	5	<50	2	10.00	<1.00	700.0	--	--	--	--
MT 2	150	70	2	500.00	1.00	7,000.0	--	--	--	--
MT 3	67	<50	36	70.00	3.00	300.0	--	--	--	--
MT 4	74	<50	52	50.00	3.00	300.0	--	--	--	--
MT 5	8	<50	15	5.00	<1.00	500.0	--	--	--	--
MT 6	640	100	20	50.00	3.00	100.0	--	--	--	--
MT 7	10	<50	8	7.00	<1.00	300.0	--	--	--	--
MT 8	8	<50	7	5.00	<1.00	300.0	--	--	--	--
MT 9	23	<50	17	70.00	<1.00	300.0	--	--	--	--
MT10	60	<50	3	70.00	<1.00	100.0	--	--	--	--
MT11	1,000	300	140	30.00	1.00	700.0	--	--	--	--
MT12	5	<50	7	7.00	<1.00	50.0	--	--	--	--
MT13	42	<50	45	300.00	<1.00	700.0	--	--	--	--
MT14	1,100	300	26	30.00	3.00	300.0	--	--	--	--
NV 1	25	20	--	8.50	<.58	720.0	--	<.85	1.50	2.10
NV 2	10	30	--	.72	<.11	9.5	--	<.16	.20	.65
NV 3	5	30	--	4.90	<.28	130.0	--	<.41	.54	1.40
NV 5	190	10	--	360.00	3.60	410.0	--	<1.70	2.50	<3.60
NV 6A	120	10	19	150.00	<.59	380.0	--	<.86	1.50	<1.90
NV 6B	--	--	--	--	--	--	--	--	--	--
NV 7	--	--	--	--	--	--	--	--	--	--
NV 8	220	10	--	87.00	<.66	800.0	--	<.97	<.97	<2.10
NV 9	180	20	--	120.00	<3.30	3,600.0	--	38.00	6.90	16.00
NV10	3	90	--	<2.40	.58	130.0	--	1.10	1.20	2.20
NV11	2	170	--	<4.60	<.99	1,200.0	--	<.15	2.30	<3.20
NV12	330	10	--	730.00	1.70	>2,500.0	--	<2.50	4.00	5.80
NV13	--	--	--	--	--	--	--	--	--	--
NV14	140	10	--	160.00	<1.00	810.0	--	<1.50	2.70	3.70
NV15	--	--	--	--	--	--	--	--	--	--
NV16	140	<50	5	100.00	<1.00	70.0	--	--	--	--
NV17	210	<50	2	100.00	<1.00	30.0	--	--	--	--
NV18	250	<10	13	400.00	<.37	37.0	--	1.80	1.50	1.30
NV19	230	10	--	240.00	<.34	40.0	--	.94	.69	1.30
NV20	210	<50.	5	100.00	<1.00	50.0	--	--	--	--
NV21	290	<50	5	50.00	<1.00	100.0	--	--	--	--
NV22	160	10	--	190.00	<.81	1,000.0	--	<1.20	1.90	<2.60
NV23	230	<50	8	100.00	<1.00	50.0	--	--	--	--
NV24	37	<50	20	50.00	<1.00	1,000.0	--	--	--	--
NV25A	--	--	--	--	--	--	--	--	--	--
NV25B	11	40	--	4.00	<.29	120.0	--	<.43	.68	1.40

Table 2.--Analyses of water samples from 163 springs in the Western States--continued

Sample	Ga ug/L	Ge ug/L	Fe ug/L	Pb ug/L	Li ug/L	Mn ug/L	Hg ug/L	Mo ug/L	Nd ug/L	Ni ug/L
ID 2	<20.00	<100.00	1,100	<70.0	850	70.0	--	20.0	--	<50.00
ID 3	<30.00	<100.00	2,700	<90.0	110	130.0	--	30.0	--	<60.00
ID 4	--	--	--	--	--	--	--	--	--	--
ID 5	--	--	--	--	--	--	--	--	--	--
ID 6	<20.00	<70.00	400	<50.0	900	140.0	--	<15.0	--	<35.00
MT 1	--	--	50	14.0	500	<10.0	<.1	70.0	--	--
MT 2	--	--	20	7.0	1,000	170.0	<.1	30.0	--	--
MT 3	--	--	80	3.0	500	10.0	<.1	50.0	--	--
MT 4	--	--	580	2.0	700	10.0	<.1	70.0	--	--
MT 5	--	--	20	4.0	300	<10.0	<.1	70.0	--	--
MT 6	--	--	170	3.0	300	60.0	<.1	30.0	--	--
MT 7	--	--	20	5.0	500	<10.0	<.1	70.0	--	--
MT 8	--	--	10	2.0	70	<10.0	<.1	70.0	--	--
MT 9	--	--	10	<1.0	300	30.0	<.1	100.0	--	--
MT10	--	--	80	16.0	70	20.0	<.1	50.0	--	--
MT11	--	--	50	1.0	100	30.0	<.1	50.0	--	--
MT12	--	--	10	1.0	50	<10.0	<.1	30.0	--	--
MT13	--	--	20	4.0	300	40.0	<.1	10.0	--	--
MT14	--	--	170	7.0	300	20.0	<.1	50.0	--	--
NV 1	<1.90	<3.90	20	<6.5	400	12.0	--	53.0	<39.0	<3.90
NV 2	<.36	<.75	20	<1.6	<11	1.5	--	3.3	<7.5	<.75
NV 3	5.80	4.90	10	<4.1	410	10.0	--	14.0	<19.0	<1.90
NV 5	<3.60	8.60	30	<17.0	1,100	94.0	--	<3.6	<76.0	<7.60
NV 6A	<1.90	<4.00	50	36.0	560	110.0	<.1	<1.9	<39.0	<3.90
NV 6B	--	--	--	--	--	--	--	--	--	--
NV 7	--	--	--	--	--	--	--	--	--	--
NV 8	<2.10	<4.40	20	<9.7	870	<4.4	--	3.4	<44.0	<4.40
NV 9	<11.00	<23.00	20	230.0	4,900	48.0	--	18.0	<230.0	<23.00
NV10	14.00	15.00	40	<7.5	900	<3.5	--	<1.7	<35.0	<3.50
NV11	5.20	15.00	80	<15.0	3,000	<6.7	--	8.9	<67.0	<6.70
NV12	<5.50	14.00	30	<25.0	7,500	60.0	--	<5.5	<120.0	<12.00
NV13	--	--	--	--	--	--	--	--	--	--
NV14	<3.30	<6.80	20	<15.0	870	50.0	--	6.7	<68.0	<6.80
NV15	--	--	--	--	--	--	--	--	--	--
NV16	--	--	10	<1.0	30	<10.0	<.1	<10.0	--	--
NV17	--	--	10	2.0	10	10.0	<.1	<10.0	--	--
NV18	1.20	<2.50	30	<1.0	92	7.6	<.1	2.8	<25.0	<2.50
NV19	<1.10	<2.30	220	<5.0	110	6.5	--	2.4	<23.0	<2.30
NV20	--	--	10	3.0	30	<10.0	<.1	<10.0	--	--
NV21	--	--	20	1.0	10	<10.0	<.1	100.0	--	--
NV22	<2.60	8.00	50	<12.0	2,400	13.0	--	6.6	<55.0	<5.50
NV23	--	--	10	3.0	30	<10.0	<.1	10.0	--	--
NV24	--	--	10	1.0	300	20.0	.1	30.0	--	--
NV25A	--	--	--	--	--	--	--	--	--	--
NV25B	4.20	<2.00	20	<4.3	180	<2.0	--	51.0	<20.0	<2.00

Table 2.--Analyses of water samples from 163 springs in the western States--continued

Sample	Sc ug/L	Se ug/L	Ag ug/L	Sr ug/L	W ug/L	V ug/L	Yb ug/L	Y ug/L	Zn ug/L	Zr ug/L
ID 2	--	--	<7.00	2,000.0	--	<30.0	--	--	10.0	<100.00
ID 3	--	--	<10.00	3,900.0	--	<40.0	--	--	20.0	<100.00
ID 4	--	--	--	--	--	--	--	--	--	--
ID 5	--	--	--	--	--	--	--	--	--	--
ID 6	--	--	<5.00	2,200.0	--	<25.0	--	--	<10.0	<70.00
MT 1	--	<1	--	300.0	--	--	--	--	7.0	--
MT 2	--	<1	--	3,000.0	--	--	--	--	<5.0	--
MT 3	--	<1	--	3,000.0	--	--	--	--	7.0	--
MT 4	--	<1	--	3,000.0	--	--	--	--	7.0	--
MT 5	--	<1	--	100.0	--	--	--	--	<5.0	--
MT 6	--	<1	--	3,000.0	--	--	--	--	10.0	--
MT 7	--	1	--	100.0	--	--	--	--	<5.0	--
MT 8	--	<1	--	100.0	--	--	--	--	5.0	--
MT 9	--	<1	--	500.0	--	--	--	--	7.0	--
MT10	--	<1	--	300.0	--	--	--	--	5.0	--
MT11	--	<1	--	5,000.0	--	--	--	--	30.0	--
MT12	--	<1	--	50.0	--	--	--	--	10.0	--
MT13	--	<1	--	500.0	--	--	--	--	10.0	--
MT14	--	<1	--	5,000.0	--	--	--	--	10.0	--
NV 1	<.85	--	<.09	120.0	<39.0	<2.7	<.090	1.50	<19.0	<3.90
NV 2	<.16	--	.02	2.6	<1.6	2.3	.020	.29	<3.6	<.75
NV 3	.45	--	<.04	29.0	<19.0	<1.3	.110	.78	<9.1	<1.90
NV 5	<1.70	--	<.17	560.0	<17.0	<5.3	<.170	3.30	<36.0	14.00
NV 6A	<.86	<1	<.09	620.0	<39.0	<27.0	<.086	<1.30	<19.0	<4.00
NV 6B	--	--	--	--	--	--	--	--	--	--
NV 7	--	--	--	--	--	--	--	--	--	--
NV 8	<.97	--	<.10	550.0	<9.7	<31.0	<.097	<1.50	21.0	<4.40
NV 9	<4.90	--	<.47	3,400.0	<230.0	<16.0	.640	10.00	<110.0	<23.00
NV10	.90	--	<.08	26.0	<35.0	<2.4	<.080	<1.10	<17.0	7.50
NV11	<1.50	--	<.15	33.0	110.0	6.1	<.150	3.30	<32.0	<6.70
NV12	<2.50	--	<.25	600.0	<120.0	<8.0	<.250	<3.80	<55.0	<12.00
NV13	--	--	--	--	--	--	--	--	--	--
NV14	<1.50	--	<.15	2,200.0	<68.0	<47.0	.160	5.90	<33.0	<6.80
NV15	--	--	--	--	--	--	--	--	--	--
NV16	--	1	--	100.0	--	--	--	--	10.0	--
NV17	--	1	--	100.0	--	--	--	--	10.0	--
NV18	<.54	<1	<.05	220.0	<5.4	<1.7	<.050	1.10	27.0	<2.50
NV19	<.50	--	<.05	430.0	<23.0	<1.6	<.050	.99	<11.0	<2.30
NV20	--	1	--	300.0	--	--	--	--	10.0	--
NV21	--	5	--	300.0	--	--	--	--	10.0	--
NV22	1.30	--	<.12	1,000.0	<55.0	<38.0	.120	2.70	<26.0	<5.50
NV23	--	1	--	300.0	--	--	--	--	30.0	--
NV24	--	<1	--	700.0	--	--	--	--	<5.0	--
NV25A	--	--	--	--	--	--	--	--	--	--
NV25B	<.43	--	<.04	160.0	51.0	<1.4	.050	<.64	<9.4	<2.00

Table 2.--Analyses of water samples from 163 springs in the Western States--continued

Sample	LATITUDE	LONGITUD	footnote	date ymd	temp C	pH fld	spc fld	TDS sum	TDS ROE	do ppm	Eh mv
NV26	38 49 18	117 11 40	.4	770,514	94	8.6	530	--	--	--	--
NV27	38 39 48	118 14 22	.3	790,629	15	7.7	900	620	--	8.20	90
NV28	38 34 15	119 11 12	.3	790,706	8	7.1	750	466	--	5.00	150
NV29	38 29 20	118 58 40	33.5	770,511	53	8.5	1,090	719	809	2.40	-20
NV30	38 20 32	118 6 12	34.5	770,512	33	7.9	1,570	1,150	1,300	.90	-60
NV31	38 17 35	118 52 55	.3	790,701	10	7.2	520	264	--	5.20	60
NV32	38 12 45	118 23 18	.3	790,630	19	8.5	1,520	950	--	1.20	-140
NV33	37 58 44	117 59 36	.5	770,513	14	7.4	4,300	2,660	3,110	7.80	--
NV34	37 49 29	117 20 11	.5	770,514	48	7.2	1,700	1,180	1,440	.60	--
NV35	37 45 22	117 37 50	.5	770,513	17	8.0	2,900	1,630	1,970	7.80	--
NV36	0 0 0B	0 0 0B	.5	--	56	7.7	720	509	765	--	--
NM 1	35 47 28	106 41 8	.1	750,608	29	6.7	6,000	3,330	4,900	--	--
NM 2	33 14 40	108 52 53	35.0	760,205	20	7.3	1,360	--	--	--	--
NM 3	33 11 55	108 12 16	36.0	760,205	68	8.1	650	--	--	--	--
NM 4	32 44 54	107 50 8	36.0	760,205	59	8.4	425	--	--	--	--
NM 5	32 33 16	107 59 40	37.0	760,205	52	7.0	560	--	--	--	--
UT 1	41 51 22	112 9 25	.8	760,429	51	7.5	14,000	8,590	--	--	--
UT 2	41 43 45	112 6 19	--	760,429	13	7.8	990	--	--	--	--
UT 3	41 43 3	112 55 34	.8	760,430	15	8.1	3,500	1,890	--	--	--
UT 4	41 42 43	112 13 41	.8	760,429	16	7.6	2,150	1,130	--	--	--
UT 5A	41 39 35	112 5 13	.4	770,518	15	7.7	1,730	--	--	--	--
UT 5B	41 39 33	112 5 13	.8	760,429	56	6.3	52,000	13,500	--	--	--
UT 6	41 37 39	112 16 40	38.8	760,430	20	7.8	20,000	13,400	--	--	-180
UT 7	41 37 15	112 16 1	.8	760,430	16	7.4	13,000	9,240	--	--	--
UT 8	41 34 48	112 15 11	.8	760,428	43	6.8	45,000	35,100	--	--	--
UT 9A	41 34 37	112 13 57	39.0	760,428	43	6.6	48,000	27,900	30,100	--	-580
UT 9B	41 34 35	112 13 57	--	760,428	43	--	35,000	--	--	--	--
UT10	41 20 13	112 1 44	40.0	760,501	54	7.4	40,000	20,400	--	--	-150
UT11	41 14 8	111 55 24	.2	750,718	56	7.0	15,000	--	--	--	--
UT12	41 8 13	112 10 30	.2	750,719	53	7.6	16,000	--	--	--	--
UT13	40 38 48	112 31 26	.1	760,502	17	7.9	30,000	20,500	--	--	--
UT14	40 31 33	111 29 15	.2	750,720	33	6.8	2,050	--	--	--	--
UT15	40 23 48	112 25 13	.1	760,502	25	8.0	1,430	574	--	--	--
UT16	39 58 30	112 45 54	.3	790,419	12	7.5	1,300	695	--	5.60	140
UT17	39 54 56	113 47 32	.3	790,418	10	7.8	500	274	--	8.30	220
UT18	39 54 30	113 25 35	41.0	770,519	59	6.9	26,000	22,200	23,800	.05	-40
UT19	39 47 18	113 11 22	.3	790,426	13	6.8	6,800	3,980	--	6.20	130
UT20	39 45 23	113 23 11	.3	790,423	23	7.2	9,100	5,920	--	4.70	-40
UT21	39 41 33	113 54 41	.3	790,421	13	7.5	560	332	--	6.70	110
UT22	39 39 49	113 55 40	.3	790,421	13	7.6	1,170	635	--	2.90	100
UT23	39 36 47	112 43 44	42.0	750,720	78	7.2	5,400	3,760	4,510	<.05	-60
UT24	39 35 38	113 4 22	.3	790,423	8	7.0	2,130	1,090	--	5.50	90
UT25	39 27 15	114 2 7	.3	790,421	26	7.6	510	317	--	5.70	140
UT26	39 26 35	112 12 33	.3	790,424	11	8.8	165	99	--	11.50	60
UT27	39 25 27	113 29 9	.3	790,422	27	7.4	2,400	1,440	--	1.00	120

Table 2.--Analyses of water samples from 163 springs in the Western States--continued

Sample	Ra pCi/L	Ra 228	U ug/L	Rn pCi/L	He ppb	REF	Ra/Spcon	UEF	U/spcon	SiO2 mgL	Ca mg/L
NV26	<.10	--	.03	--	--	<9.80	<.190	>.1000	.0570	--	--
NV27	.09	--	12.00	400	--	.02	.100	45.0000	13.0000	33.0	92.0
NV28	.40	--	120.00	1,100	--	.01	.530	100.0000	160.0000	48.0	60.0
NV29	7.30	--	.90	110,000	--	24.00	6.700	.0420	.8300	34.0	26.0
NV30	.20	--	<.01	820	--	>59.00	.130	<.0170	<.0064	42.0	43.0
NV31	.10	--	1.40	77	--	.21	.190	4.7000	2.7000	21.0	48.0
NV32	.07	--	.22	900	--	.94	.046	1.1000	.1400	88.0	18.0
NV33	11.00	--	6.80	--	--	4.80	2.600	.2100	1.6000	13.0	120.0
NV34	.90	--	.02	--	--	130.00	.530	.0075	.0120	53.0	48.0
NV35	.20	--	14.00	--	--	.04	.069	24.0000	4.8000	44.0	140.0
NV36	4.50	--	.04	--	--	330.00	6.300	.0030	.0560	98.0	14.0
NM 1	230.00	--	.60	--	--	1,100.00	38.000	.0009	.1000	5.8	230.0
NM 2	3.40	--	1.40	1,300	--	7.20	2.500	.1400	1.0000	--	--
NM 3	.29	--	1.60	660	--	.53	.450	1.9000	2.5000	--	--
NM 4	.48	--	.39	2,300	--	3.60	1.100	.2800	.9200	--	--
NM 5	20.00	--	.04	5,600	--	1,500.00	36.000	.0007	.0710	--	--
UT 1	32.00	--	.80	1,400	--	120.00	2.300	.0085	.0570	25.0	220.0
UT 2	4.20	--	1.90	--	--	6.50	4.200	.1500	1.9000	--	--
UT 3	.09	--	2.70	--	--	.10	.026	10.0000	.7700	37.0	110.0
UT 4	.30	--	1.90	--	--	.47	.140	2.1000	.8800	17.0	74.0
UT 5A	2.00	--	2.30	--	--	2.60	1.200	.3900	1.3000	--	--
UT 5B	220.00	--	1.50	2,500	--	430.00	4.200	.0023	.0290	27.0	800.0
UT 6	3.10	--	1.70	6,500	--	5.40	.140	.1900	.0770	27.0	260.0
UT 7	2.90	--	2.00	500	--	4.30	.220	.2300	.1500	22.0	210.0
UT 8	53.00	--	1.50	4,600	--	100.00	1.200	.0096	.0330	24.0	700.0
UT 9A	75.00	--	<.01	2,000	2,600	>22,000.00	2.100	<.0001	<.0003	36.0	740.0
UT 9B	120.00	--	.06	--	--	5,900.00	3.400	.0002	.0017	--	--
UT10	66.00	--	.04	1,200	13,000	4,900.00	2.200	.0002	.0013	33.0	910.0
UT11	21.00	--	.28	2,200	--	220.00	1.400	.0045	.0190	--	--
UT12	74.00	--	.08	1,500	--	2,700.00	4.600	.0004	.0050	--	--
UT13	5.00	--	1.40	--	--	11.00	.170	.0950	.0470	33.0	510.0
UT14	.20	--	.89	260	--	.66	.098	1.5000	.4300	--	--
UT15	.26	--	.50	--	--	1.50	.180	.6500	.3500	19.0	54.0
UT16	.31	--	1.90	310	2,800	.48	.240	2.1000	1.5000	12.0	74.0
UT17	.18	--	1.40	140	0	.38	.360	2.6000	2.8000	11.0	56.0
UT18	130.00	--	.17	1,800	3,200	2,300.00	5.000	.0004	.0065	34.0	730.0
UT19	5.30	--	110.00	12,000	>90	.16	.850	6.4000	16.0000	25.0	610.0
UT20	1.60	--	4.70	49	510	1.00	.180	1.0000	.5200	21.0	290.0
UT21	.74	--	3.10	170	58	.70	1.300	1.4000	5.5000	18.0	63.0
UT22	9.10	--	11.00	2,800	410	2.40	7.800	.4100	9.4000	12.0	74.0
UT23	3.60	--	.15	240	1,300	71.00	.670	.0140	.0280	60.0	390.0
UT24	.10	--	15.00	2,100	120	.02	.047	51.0000	7.0000	3.3	170.0
UT25	.21	--	3.10	200	870	.20	.410	5.0000	6.1000	21.0	54.0
UT26	.22	--	.21	19	-60	3.10	1.300	.3200	1.3000	15.0	21.0
UT27	1.30	--	2.00	520	840	1.90	.540	.5200	.8300	22.0	76.0

Table 2.--Analyses of water samples from 163 springs in the Western States--continued

Sample	Mg mg/L	Na mg/L	K mg/L	HCO3 mgL	CO3 mg/L	SO4 mg/L	Cl mg/L	F mg/L	NO2+NO3	orthoPO4	lab alk
NV26	--	--	--	--	--	--	--	--	--	--	--
NV27	23.0	67.0	1.6	244	<1	210.0	69.0	.5	.78	--	200
NV28	23.0	64.0	9.1	366	<1	52.0	28.0	.4	.22	--	300
NV29	.1	200.0	2.2	38	<1	380.0	49.0	8.4	.01	.12	31
NV30	3.3	320.0	16.0	110	<1	590.0	73.0	8.8	.03	.03	90
NV31	8.9	27.0	2.2	171	<1	63.0	8.7	.4	<.01	--	140
NV32	.3	290.0	10.0	68	<1	250.0	250.0	9.5	.01	--	56
NV33	44.0	780.0	68.0	740	<1	430.0	830.0	8.6	1.10	.12	610
NV34	3.4	340.0	23.0	320	<1	490.0	57.0	8.6	.01	.06	260
NV35	61.0	340.0	19.0	150	<1	220.0	720.0	1.1	1.90	.06	120
NV36	.2	160.0	5.4	370	<1	20.0	15.0	14.0	.02	.09	300
NM 1	23.0	980.0	190.0	721	<1	43.0	1,500.0	.4	.03	.03	591
NM 2	--	--	--	--	--	--	--	--	--	--	--
NM 3	--	--	--	--	--	--	--	--	--	--	--
NM 4	--	--	--	--	--	--	--	--	--	--	--
NM 5	--	--	--	--	--	--	--	--	--	--	--
UT 1	56.0	2,900.0	140.0	302	<1	95.0	5,000.0	1.2	.01	.09	248
UT 2	--	--	--	--	--	--	--	--	--	--	--
UT 3	53.0	500.0	38.0	210	<1	90.0	960.0	.4	.63	.06	172
UT 4	35.0	310.0	17.0	282	<1	39.0	490.0	.4	1.70	<.01	231
UT 5A	--	--	--	--	--	--	--	--	--	--	--
UT 5B	180.0	15,000.0	780.0	471	<1	470.0	26,000.0	1.3	.11	.28	386
UT 6	150.0	4,700.0	200.0	310	<1	180.0	7,700.0	.9	1.40	.15	254
UT 7	110.0	3,100.0	120.0	261	<1	130.0	5,400.0	.7	3.40	.09	214
UT 8	220.0	12,000.0	590.0	530	<1	300.0	21,000.0	1.4	.16	.25	435
UT 9A	330.0	9,000.0	490.0	443	<1	79.0	17,000.0	.9	.04	.28	363
UT 9B	--	--	--	--	--	--	--	--	--	--	--
UT10	25.0	6,300.0	870.0	195	<1	180.0	12,000.0	3.7	.02	.18	160
UT11	--	--	--	--	--	--	--	--	--	--	--
UT12	--	--	--	--	--	--	--	.4	--	--	--
UT13	130.0	6,900.0	220.0	253	<1	570.0	12,000.0	.8	.01	.21	208
UT14	--	--	--	--	--	--	--	--	--	--	--
UT15	24.0	110.0	12.0	173	<1	88.0	180.0	1.1	.04	<.01	142
UT16	34.0	140.0	2.1	305	<1	67.0	210.0	.2	1.20	--	250
UT17	20.0	20.0	1.2	244	<1	21.0	24.0	.2	.11	--	200
UT18	200.0	7,300.0	250.0	140	<1	1,600.0	12,000.0	1.9	.01	.15	140
UT19	140.0	650.0	10.0	219	<1	330.0	2,100.0	.4	1.90	--	180
UT20	110.0	1,700.0	93.0	427	<1	490.0	3,000.0	.8	.01	--	350
UT21	13.0	27.0	2.0	134	<1	110.0	32.0	.2	.09	--	110
UT22	35.0	100.0	6.1	195	<1	130.0	180.0	.9	.11	--	160
UT23	53.0	850.0	59.0	150	<1	700.0	1,500.0	2.7	.01	--	120
UT24	33.0	190.0	7.5	293	<1	97.0	440.0	.9	.75	--	240
UT25	17.0	29.0	4.0	232	<1	54.0	20.0	.7	.68	--	190
UT26	3.9	7.7	1.4	70	2	5.9	7.6	.2	.09	--	59
UT27	41.0	370.0	36.0	256	<1	320.0	450.0	1.1	.11	--	210

Table 2.--Analyses of water samples from 163 springs in the Western States--continued

Sample	hard tot	Al ug/L	As ug/L	Ba ug/L	Be ug/L	B ug/L	Cd ug/L	Cr ug/L	Co ug/L	Cu ug/L
NV26	--	--	--	--	--	--	--	--	--	--
NV27	320	100	5	50.00	<1.00	100.0	--	--	--	--
NV28	240	300	5	70.00	<1.00	70.0	--	--	--	--
NV29	65	20	--	15.00	<.55	>810.0	--	<.81	<1.60	3.50
NV30	120	20	--	21.00	<.88	1,100.0	--	<1.30	<1.30	<2.90
NV31	160	100	7	70.00	<1.00	50.0	--	--	--	--
NV32	46	<50	19	7.00	<1.00	3,000.0	--	--	--	--
NV33	480	40	--	27.00	<2.10	>3,100.0	--	<3.10	4.70	11.00
NV34	130	10	--	40.00	<.98	590.0	--	2.20	2.30	3.60
NV35	600	<10	--	47.00	<1.30	1,700.0	--	<2.00	5.90	7.10
NV36	36	<10	--	120.00	1.70	99.0	--	1.20	1.20	<1.70
NM 1	670	60	--	430.00	<7.00	13,000.0	<1	<25.00	<25.00	<5.00
NM 2	--	--	--	--	--	--	--	--	--	--
NM 3	--	--	--	--	--	--	--	--	--	--
NM 4	--	--	--	--	--	--	--	--	--	--
NM 5	--	--	--	--	--	--	--	--	--	--
UT 1	780	150	--	4,500.00	<10.00	800.0	<1	<40.00	<40.00	20.00
UT 2	--	--	--	--	--	--	--	--	--	--
UT 3	490	50	--	--	<3.00	200.0	<1	<10.00	<10.00	<3.00
UT 4	330	20	--	50.00	<2.00	150.0	<1	<10.00	<10.00	<2.00
UT 5A	--	--	--	--	--	--	--	--	--	--
UT 5B	2,700	1,200	--	400.00	<50.00	4,000.0	<1	<170.00	<170.00	<45.00
UT 6	1,300	200	--	100.00	<20.00	1,500.0	<1	<70.00	<70.00	<20.00
UT 7	980	130	--	200.00	<10.00	1,000.0	<1	<40.00	<40.00	<10.00
UT 8	2,700	870	--	400.00	<40.00	4,000.0	<1	<150.00	<150.00	<40.00
UT 9A	3,200	1,400	23	7,600.00	<30.00	3,100.0	<1	<120.00	<120.00	<30.00
UT 9B	--	--	--	--	--	--	--	--	--	--
UT10	2,200	370	20	500.00	<70.00	2,800.0	<1	<300.00	<300.00	<65.00
UT11	--	--	--	--	--	--	--	--	--	--
UT12	--	--	--	--	--	--	--	--	--	--
UT13	1,800	270	--	100.00	<30.00	1,100.0	<1	<100.00	<100.00	<20.00
UT14	--	--	--	--	--	--	--	--	--	--
UT15	230	20	--	70.00	<1.00	180.0	<1	<10.00	<10.00	<1.00
UT16	320	100	1	70.00	<1.00	100.0	--	--	--	--
UT17	220	100	<1	70.00	7.00	50.0	--	--	--	--
UT18	2,600	10	65	120.00	1.00	1,600.0	--	<24.00	<24.00	<52.00
UT19	2,100	1,000	1	70.00	5.00	300.0	--	--	--	--
UT20	1,200	500	7	30.00	<1.00	1,000.0	--	--	--	--
UT21	210	<50	<1	30.00	<1.00	50.0	--	--	--	--
UT22	330	100	<1	50.00	<1.00	100.0	--	--	--	--
UT23	1,200	50	20	95.00	<1.00	520.0	<1	<20.00	<20.00	<5.00
UT24	560	100	3	10.00	<1.00	100.0	--	--	--	--
UT25	200	50	2	100.00	<1.00	70.0	--	--	--	--
UT26	67	<50	1	30.00	<1.00	30.0	--	--	--	--
UT27	360	100	17	30.00	<1.00	500.0	--	--	--	--

Table 2.--Analyses of water samples from 163 springs in the Western States--continued

Sample	Ga ug/L	Ge ug/L	Fe ug/L	Pb ug/L	Li ug/L	Mn ug/L	Hg ug/L	Mo ug/L	Nd ug/L	Ni ug/L
NV26	--	--	--	--	--	--	--	--	--	--
NV27	--	--	<10	35.0	10	2.0	<.1	<10.0	--	--
NV28	--	--	<10	3.0	30	1.0	<.1	30.0	--	--
NV29	2.10	<3.70	20	<6.1	1,100	6.6	--	76.0	<37.0	<3.70
NV30	<2.90	<6.00	100	<13.0	1,300	92.0	--	7.8	<60.0	<6.00
NV31	--	--	60	<1.0	30	130.0	<.1	10.0	--	--
NV32	--	--	<10	<1.0	500	7.0	<.1	10.0	--	--
NV33	<6.80	<14.00	410	<31.0	6,200	53.0	--	37.0	<140.0	<14.00
NV34	<3.20	<6.60	70	<14.0	4,800	330.0	--	<3.2	<66.0	<6.60
NV35	<4.30	<9.10	30	<20.0	1,500	<9.1	--	7.1	<91.0	<9.10
NV36	<1.70	6.40	40	<7.7	1,100	92.0	--	2.2	<35.0	<3.50
NM 1	<10.00	<35.00	<35	<25.0	13,000	30.0	--	20.0	--	<25.00
NM 2	--	--	--	--	--	--	--	--	--	--
NM 3	--	--	--	--	--	--	--	--	--	--
NM 4	--	--	--	--	--	--	--	--	--	--
NM 5	--	--	--	--	--	--	--	--	--	--
UT 1	<20.00	<50.00	200	<40.0	1,300	20.0	--	100.0	--	<40.00
UT 2	--	--	--	--	--	--	--	--	--	--
UT 3	<5.00	<20.00	20	<10.0	220	<10.0	--	20.0	--	<10.00
UT 4	<4.00	<10.00	<10	<10.0	150	<10.0	--	15.0	--	<10.00
UT 5A	--	--	--	--	--	--	--	--	--	--
UT 5B	<90.00	<220.00	1,300	<170.0	7,100	90.0	--	380.0	--	<170.00
UT 6	<30.00	<80.00	100	<70.0	2,100	60.0	--	110.0	--	<70.00
UT 7	<20.00	<50.00	<20	<40.0	1,400	60.0	--	90.0	--	<40.00
UT 8	<80.00	<200.00	1,500	<150.0	5,600	90.0	--	380.0	--	<150.00
UT 9A	<60.00	<140.00	400	24.0	4,800	100.0	.1	160.0	--	<120.00
UT 9B	--	--	--	--	--	--	--	--	--	--
UT10	<130.00	<600.00	5,000	1.0	9,800	1,700.0	4.1	260.0	--	<300.00
UT11	--	--	--	--	--	--	--	--	--	--
UT12	--	--	--	--	--	--	--	--	--	--
UT13	<50.00	<110.00	<50	<100.0	2,300	90.0	--	170.0	--	<100.00
UT14	--	--	--	--	--	--	--	--	--	--
UT15	<2.00	<5.00	<20	<10.0	40	3.0	--	10.0	--	<10.00
UT16	--	--	10	<1.0	50	<10.0	<.1	<10.0	--	--
UT17	--	--	10	<1.0	10	<10.0	<.1	<10.0	--	--
UT18	<52.00	<110.00	190	<1.0	11,000	210.0	.1	<52.0	2,000.0	<110.00
UT19	--	--	350	2.0	100	40.0	9.0	10.0	--	--
UT20	--	--	120	<1.0	1,000	50.0	<.1	10.0	--	--
UT21	--	--	10	<1.0	10	<10.0	<.1	<10.0	--	--
UT22	--	--	20	<1.0	50	10.0	<.1	<10.0	--	--
UT23	<10.00	<20.00	120	<1.0	900	310.0	.1	40.0	--	<20.00
UT24	--	--	10	<1.0	50	<10.0	<.1	<10.0	--	--
UT25	--	--	20	<1.0	30	<10.0	<.1	<10.0	--	--
UT26	--	--	30	<1.0	<10	<10.0	<.1	<10.0	--	--
UT27	--	--	20	<1.0	500	<10.0	<.1	<10.0	--	--

Table 2.--Analyses of water samples from 163 springs in the Western States--continued

Sample	Sc ug/L	Se ug/L	Ag ug/L	Sr ug/L	W ug/L	V ug/L	Yb ug/L	Y ug/L	Zn ug/L	Zr ug/L
NV26	--	--	--	--	--	--	--	--	--	--
NV27	--	2	--	1,000.0	--	--	--	--	<5.0	--
NV28	--	<1	--	700.0	--	--	--	--	<5.0	--
NV29	<.81	--	<.08	1,100.0	190.0	<2.6	<.080	<1.20	<18.0	<3.70
NV30	1.40	--	<.13	2,100.0	130.0	<4.2	<.130	2.60	<29.0	<6.00
NV31	--	<1	--	500.0	--	--	--	--	700.0	--
NV32	--	<1	--	300.0	--	--	--	--	<5.0	--
NV33	<3.10	--	<.31	2,200.0	<140.0	<10.0	<.310	8.10	<68.0	<14.00
NV34	<1.40	--	<.14	1,700.0	<66.0	<4.6	<.140	2.90	36.0	<6.60
NV35	<2.20	--	.26	3,500.0	<91.0	7.5	<.200	<3.00	<43.0	<9.10
NV36	<.77	--	<.08	340.0	120.0	<2.5	<.080	1.20	<17.0	<3.50
NM 1	--	--	<.30	1,300.0	--	<25.0	--	--	10.0	<35.00
NM 2	--	--	--	--	--	--	--	--	--	--
NM 3	--	--	--	--	--	--	--	--	--	--
NM 4	--	--	--	--	--	--	--	--	--	--
NM 5	--	--	--	--	--	--	--	--	--	--
UT 1	--	--	<5.00	9,300.0	--	<30.0	--	--	30.0	<70.00
UT 2	--	--	--	--	--	--	--	--	--	--
UT 3	--	--	<2.00	2,400.0	--	<10.0	--	--	<10.0	<20.00
UT 4	--	--	<1.00	1,700.0	--	<10.0	--	--	<10.0	<10.00
UT 5A	--	--	--	--	--	--	--	--	--	--
UT 5B	--	--	<20.00	38,000.0	--	<130.0	--	--	50.0	<300.00
UT 6	--	--	<7.00	11,000.0	--	<50.0	--	--	40.0	<100.00
UT 7	--	--	<5.00	8,200.0	--	<30.0	--	--	30.0	<70.00
UT 8	--	--	<17.00	32,000.0	--	<110.0	--	--	40.0	<260.00
UT 9A	--	<1	<13.00	30,000.0	--	<90.0	--	--	30.0	<200.00
UT 9B	--	--	--	--	--	--	--	--	--	--
UT10	--	<1	<30.00	24,000.0	--	<200.0	--	--	20.0	<440.00
UT11	--	--	--	--	--	--	--	--	--	--
UT12	--	--	--	--	--	--	--	--	--	--
UT13	--	--	<10.00	8,000.0	--	<70.0	--	--	40.0	<150.00
UT14	--	--	--	--	--	--	--	--	--	--
UT15	--	--	<1.00	1,500.0	--	<5.0	--	--	<10.0	<6.00
UT16	--	1	--	300.0	--	--	--	--	5.0	--
UT17	--	<1	--	300.0	--	--	--	--	<5.0	--
UT18	<24.00	<1	<2.40	13,000.0	<240.0	<76.0	2.400	<36.00	30.0	<110.00
UT19	--	4	--	7,000.0	--	--	--	--	10.0	--
UT20	--	<1	--	5,000.0	--	--	--	--	10.0	--
UT21	--	<1	--	500.0	--	--	--	--	<5.0	--
UT22	--	2	--	1,000.0	--	--	--	--	10.0	--
UT23	--	<1	<2.00	5,400.0	--	<20.0	--	--	20.0	<30.00
UT24	--	1	--	1,000.0	--	--	--	--	5.0	--
UT25	--	<1	--	300.0	--	--	--	--	<5.0	--
UT26	--	<1	--	100.0	--	--	--	--	<5.0	--
UT27	--	<1	--	1,000.0	--	--	--	--	<5.0	--

Table 2.--Analyses of water samples from 163 springs in the Western States--continued

Sample	LATITUDE	LONGITUD	footnote	date ymd	temp C	pH fld	spc fld	TDS sum	TDS ROE	do ppm	Eh mv
UT28	39 24 13	113 16 38	.3	790,423	9	7.6	770	382	--	8.50	120
UT29	39 24 12	113 51 42	.3	790,420	19	7.0	800	449	--	5.00	110
UT30	39 22 16	113 18 55	.3	790,422	8	7.8	770	407	--	5.50	110
UT31	39 21 5	113 30 50	.3	790,422	27	7.4	1,580	969	--	2.70	120
UT32	39 20 3	112 17 48	.3	790,424	6	7.7	900	523	--	7.30	100
UT33	39 16 27	112 17 50	.3	790,424	9	7.2	590	331	--	7.30	110
UT34	39 15 10	113 52 25	.3	790,420	22	7.4	800	470	--	6.40	-170
UT35	39 14 50	112 11 51	.3	790,425	7	7.5	750	426	--	8.00	90
UT36A	39 14 19	111 39 19	43.1	760,503	11	7.8	5,600	3,120	--	1.70	-350
UT36B	39 14 14	111 39 23	--	760,503	14	7.2	3,100	--	--	--	--
UT37	39 13 43	111 50 35	--	760,503	18	7.6	1,030	--	--	--	--
UT38	39 10 19	111 42 9	--	760,503	12	7.8	1,490	--	--	--	--
UT39	39 6 24	112 12 54	.3	790,425	11	7.3	530	300	--	7.50	100
UT40	39 5 18	112 24 34	.3	790,425	15	6.9	1,540	1,150	--	5.50	120
UT41	38 38 21	112 5 51	44.9	750,721	74	6.8	3,800	--	--	2.20	-130
UT43	38 10 22	113 12 13	36.9	750,723	59	8.0	2,200	--	--	--	--
UT44	37 11 21	113 16 16	2.9	750,723	42	6.6	15,000	--	--	--	--
WY 1	43 39 54	108 11 41	.1	760,625	53	6.4	3,050	2,270	--	--	--
WY 2	43 39 18	108 11 52	.1	760,625	34	7.6	3,200	2,330	--	--	--
WY 3	43 39 17	108 11 37	--	760,624	56	6.3	3,000	--	--	--	--
WY 4	43 34 56	108 12 45	--	760,625	20	7.1	1,180	--	--	--	--
WY 5	43 22 12	110 26 41	.9	760,627	35	7.9	930	--	--	--	--
WY 6	43 18 1	110 46 28	.9	760,627	41	7.2	1,630	--	--	--	--
WY 7	43 17 20	110 38 5	--	760,626	8	7.5	1,630	--	--	--	--
WY 8	43 0 28	108 50 6	.1	760,623	38	7.9	1,120	728	--	--	--
WY 9	42 49 54	110 59 57	.1	760,627	62	7.0	7,700	5,480	--	--	--
WY10A	41 29 33	107 32 43	--	760,622	12	8.0	2,080	--	--	--	--
WY10B	41 29 33	107 32 43	--	760,622	10	7.1	1,560	--	--	--	--

Table 2.--Analyses of water samples from 163 springs in the Western States--continued

Sample	Ra pCi/L	Ra 228	U ug/L	Rn pCi/L	He ppb	REF	Ra/Spcon	UEF	U/spcon	SiO2 mgL	Ca mg/L
UT28	.08	--	2.00	100	0	.12	.100	8.5000	2.6000	11.0	54.0
UT29	2.50	--	3.10	21	3,000	2.40	3.100	.4200	3.9000	17.0	68.0
UT30	.11	--	1.10	370	30	.30	.140	3.4000	1.4000	8.9	40.0
UT31	1.20	--	2.60	260	700	1.40	.760	.7300	1.6000	22.0	71.0
UT32	.15	--	1.80	420	0	.25	.170	4.1000	2.0000	49.0	83.0
UT33	.13	--	.50	36	30	.77	.220	1.3000	.8500	28.0	77.0
UT34	.83	--	3.40	640	870	.72	1.000	1.4000	4.3000	19.0	75.0
UT35	.06	--	1.00	95	0	.18	.080	5.7000	1.3000	10.0	98.0
UT36A	38.00	--	.02	100	460	1,600.00	6.800	.0006	.0130	15.0	45.0
UT36B	4.00	--	.10	--	--	120.00	1.300	.0085	.0320	--	--
UT37	.49	--	1.60	--	--	.90	.480	1.1000	1.6000	--	--
UT38	.22	--	4.70	--	--	.14	.150	7.2000	3.2000	--	--
UT39	.08	--	.35	110	60	.67	.150	1.5000	.6600	24.0	65.0
UT40	.07	--	1.30	29	--	.16	.046	6.3000	.8400	11.0	250.0
UT41	6.30	--	.03	710	1,400	620.00	1.700	.0016	.0079	--	--
UT43	7.50	--	<.05	600	--	>440.00	3.400	<.0023	<.0230	--	--
UT44	41.00	--	.60	550	--	200.00	2.700	.0050	.0400	--	--
WY 1	15.00	--	.10	--	--	440.00	4.900	.0023	.0330	33.0	370.0
WY 2	13.00	--	.05	--	--	1,100.00	5.600	.0009	.0160	34.0	370.0
WY 3	15.00	--	.10	--	--	440.00	5.000	.0023	.0330	--	--
WY 4	3.50	--	2.80	--	--	3.70	3.000	.2700	2.4000	--	--
WY 5	1.80	--	.10	--	--	53.00	1.900	.0190	.1100	--	--
WY 6	3.10	--	.20	--	--	46.00	1.900	.0220	.1200	--	--
WY 7	.34	--	.80	--	--	1.30	.210	.8000	.4900	--	--
WY 8	61.00	--	.03	--	--	6,000.00	54.000	.0002	.0270	34.0	140.0
WY 9	31.00	--	.04	--	--	2,300.00	4.000	.0004	.0052	36.0	410.0
WY10A	.47	--	.10	--	--	14.00	.230	.0720	.0480	--	--
WY10B	.36	--	.07	--	--	15.00	.230	.0660	.0450	--	--

Table 2.--Analyses of water samples from 163 springs in the Western States--continued

Sample	Mg mg/L	Na mg/L	K mg/L	HCO3 mgL	CO3 mg/L	SO4 mg/L	Cl mg/L	F mg/L	NO2+NO3	orthoPO4	lab alk
UT28	29.0	52.0	1.7	280	<1	26.0	69.0	.2	.29	--	230
UT29	29.0	56.0	5.8	293	<1	64.0	64.0	.7	.14	--	240
UT30	27.0	73.0	1.5	219	<1	37.0	100.0	.2	1.30	--	180
UT31	35.0	200.0	21.0	219	<1	280.0	230.0	1.1	.22	--	180
UT32	52.0	28.0	3.0	402	<1	22.0	66.0	.3	4.90	--	330
UT33	28.0	8.0	.8	341	<1	8.7	11.0	.1	.26	--	280
UT34	30.0	49.0	5.9	305	<1	84.0	56.0	.6	.04	--	250
UT35	21.0	40.0	1.8	317	<1	51.0	46.0	.1	.43	--	260
UT36A	23.0	1,200.0	19.0	1,420	<1	16.0	1,100.0	2.7	.16	.34	1,160
UT36B	--	--	--	--	--	--	--	--	--	--	--
UT37	--	--	--	--	--	--	--	--	--	--	--
UT38	--	--	--	--	--	--	--	--	--	--	--
UT39	24.0	14.0	1.1	293	<1	8.1	18.0	.2	.24	--	240
UT40	15.0	47.0	1.8	256	<1	630.0	64.0	.1	.21	--	210
UT41	--	--	--	--	--	--	--	3.0	--	--	--
UT43	--	--	--	--	--	--	--	4.8	--	--	--
UT44	--	--	--	--	--	--	--	3.4	--	--	--
WY 1	77.0	260.0	50.0	756	<1	790.0	310.0	3.3	<.01	.21	620
WY 2	74.0	270.0	53.0	771	<1	790.0	350.0	3.5	<.01	.25	632
WY 3	--	--	--	--	--	--	--	--	--	--	--
WY 4	--	--	--	--	--	--	--	--	--	--	--
WY 5	--	--	--	--	--	--	--	4.8	--	--	--
WY 6	--	--	--	--	--	--	--	2.5	--	--	--
WY 7	--	--	--	--	--	--	--	--	--	--	--
WY 8	34.0	42.0	15.0	216	<1	310.0	43.0	2.9	<.01	.18	177
WY 9	68.0	1,300.0	150.0	827	<1	1,300.0	1,800.0	3.6	<.01	.46	678
WY10A	--	--	--	--	--	--	--	--	--	--	--
WY10B	--	--	--	--	--	--	--	--	--	--	--

Table 2.--Analyses of water samples from 163 springs in the Western States--continued

Sample	hard tot	Al ug/L	As ug/L	Ba ug/L	Be ug/L	B ug/L	Cd ug/L	Cr ug/L	Co ug/L	Cu ug/L
UT28	250	100	1	30.00	<1.00	50.0	--	--	--	--
UT29	290	100	5	50.00	<1.00	70.0	--	--	--	--
UT30	210	100	<1	30.00	<1.00	70.0	--	--	--	--
UT31	320	100	16	30.00	<1.00	300.0	--	--	--	--
UT32	420	300	1	500.00	<1.00	70.0	--	--	--	--
UT33	310	100	<1	50.00	<1.00	30.0	--	--	--	--
UT34	310	100	7	100.00	<1.00	100.0	--	--	--	--
UT35	330	<50	<1	70.00	<1.00	70.0	--	--	--	--
UT36A	210	70	--	800.00	<10.00	1,500.0	<1	<55.00	<55.00	<12.00
UT36B	--	--	--	--	--	--	--	--	--	--
UT37	--	--	--	--	--	--	--	--	--	--
UT38	--	--	--	--	--	--	--	--	--	--
UT39	260	70	<1	100.00	<1.00	30.0	--	--	--	--
UT40	690	300	1	10.00	<1.00	100.0	--	--	--	--
UT41	--	300	170	50.00	<1.00	3,000.0	--	--	--	--
UT43	--	--	--	--	--	--	--	--	--	--
UT44	--	--	--	--	--	--	--	--	--	--
WY 1	1,200	30	--	50.00	<20.00	500.0	<1	<45.00	<45.00	<10.00
WY 2	1,200	30	--	50.00	<20.00	500.0	<1	<45.00	<45.00	<10.00
WY 3	--	--	--	--	--	--	--	--	--	--
WY 4	--	--	--	--	--	--	--	--	--	--
WY 5	--	--	--	--	--	--	--	--	--	--
WY 6	--	--	--	--	--	--	--	--	--	--
WY 7	--	--	--	--	--	--	--	--	--	--
WY 8	490	10	--	50.00	<5.00	100.0	<1	<15.00	<15.00	<4.00
WY 9	1,300	40	--	50.00	<30.00	1,500.0	<1	<90.00	<90.00	<20.00
WY10A	--	--	--	--	--	--	--	--	--	--
WY10B	--	--	--	--	--	--	--	--	--	--

Table 2.--Analyses of water samples from 163 springs in the Western States--continued

Sample	Ga ug/L	Ge ug/L	Fe ug/L	Pb ug/L	Li ug/L	Mn ug/L	Hg ug/L	Mo ug/L	Nd ug/L	Ni ug/L
UT28	--	--	10	<1.0	30	<10.0	<.1	<10.0	--	--
UT29	--	--	10	<1.0	70	<10.0	<.1	<10.0	--	--
UT30	--	--	10	<1.0	30	<10.0	<.1	<10.0	--	--
UT31	--	--	20	<1.0	300	<10.0	<.1	<10.0	--	--
UT32	--	--	10	<1.0	30	10.0	<.1	<10.0	--	--
UT33	--	--	20	<1.0	10	<10.0	<.1	<10.0	--	--
UT34	--	--	30	<1.0	50	<10.0	.1	<10.0	--	--
UT35	--	--	40	<1.0	30	10.0	<.1	<10.0	--	--
UT36A	<30.00	<100.00	60	<35.0	180	<40.0	--	50.0	--	<55.00
UT36B	--	--	--	--	--	--	--	--	--	--
UT37	--	--	--	--	--	--	--	--	--	--
UT38	--	--	--	--	--	--	--	--	--	--
UT39	--	--	10	<1.0	10	<10.0	<.1	<10.0	--	--
UT40	--	--	20	<1.0	70	<10.0	<.1	<10.0	--	--
UT41	--	--	50	<1.0	700	70.0	<.1	<10.0	--	--
UT43	--	--	--	--	--	--	--	--	--	--
UT44	--	--	--	--	--	--	--	--	--	--
WY 1	<20.00	<90.00	130	<60.0	850	50.0	--	<20.0	--	<45.00
WY 2	<20.00	<90.00	170	<60.0	930	50.0	--	20.0	--	<45.00
WY 3	--	--	--	--	--	--	--	--	--	--
WY 4	--	--	--	--	--	--	--	--	--	--
WY 5	--	--	--	--	--	--	--	--	--	--
WY 6	--	--	--	--	--	--	--	--	--	--
WY 7	--	--	--	--	--	--	--	--	--	--
WY 8	<6.00	<30.00	60	<20.0	160	20.0	--	6.0	--	<15.00
WY 9	<40.00	<180.00	130	<130.0	1,600	140.0	--	<40.0	--	<90.00
WY10A	--	--	--	--	--	--	--	--	--	--
WY10B	--	--	--	--	--	--	--	--	--	--

Table 2.--Analyses of water samples from 163 springs in the Western States--continued

Sample	Sc ug/L	Se ug/L	Ag ug/L	Sr ug/L	W ug/L	V ug/L	Yb ug/L	Y ug/L	Zn ug/L	Zr ug/L
UT28	--	<1	--	300.0	--	--	--	--	<5.0	--
UT29	--	1	--	700.0	--	--	--	--	<5.0	--
UT30	--	<1	--	300.0	--	--	--	--	5.0	--
UT31	--	<1	--	1,000.0	--	--	--	--	<5.0	--
UT32	--	1	--	300.0	--	--	--	--	10.0	--
UT33	--	<1	--	100.0	--	--	--	--	<5.0	--
UT34	--	1	--	1,000.0	--	--	--	--	<5.0	--
UT35	--	<1	--	300.0	--	--	--	--	<5.0	--
UT36A	--	--	<6.00	2,500.0	--	<35.0	--	--	<10.0	<80.00
UT36B	--	--	--	--	--	--	--	--	--	--
UT37	--	--	--	--	--	--	--	--	--	--
UT38	--	--	--	--	--	--	--	--	--	--
UT39	--	<1	--	100.0	--	--	--	--	<5.0	--
UT40	--	<1	--	3,000.0	--	--	--	--	7.0	--
UT41	--	<1	--	5,000.0	--	--	--	--	<5.0	--
UT43	--	--	--	--	--	--	--	--	--	--
UT44	--	--	--	--	--	--	--	--	--	--
WY 1	--	--	<6.00	4,000.0	--	<30.0	--	--	<10.0	<90.00
WY 2	--	--	<6.00	4,000.0	--	<30.0	--	--	<10.0	<90.00
WY 3	--	--	--	--	--	--	--	--	--	--
WY 4	--	--	--	--	--	--	--	--	--	--
WY 5	--	--	--	--	--	--	--	--	--	--
WY 6	--	--	--	--	--	--	--	--	--	--
WY 7	--	--	--	--	--	--	--	--	--	--
WY 8	--	--	<2.00	5,600.0	--	20.0	--	--	<10.0	<30.00
WY 9	--	--	<10.00	8,500.0	--	<60.0	--	--	<10.0	<180.00
WY10A	--	--	--	--	--	--	--	--	--	--
WY10B	--	--	--	--	--	--	--	--	--	--

Table 2 footnotes:

[1] Pb done by SPEC.

[2] Rn from O'Connell and Kaufmann (1976).

[3] Al, Ba, Be, B, Li, Mo, Sr, and Zn done by ICP; Fe and Mn done by WC.

[4] Ra value is for total radium done by PLN.

[5] Ra value is for toal radium done by PLN. Al and Fe done by WC; Pb, Li, and Zn done by SPEC.

[6] Pb, Li, and Zn done by SPEC.

[7] Li and Zn done by SPEC.

[8] Pb done by SPEC; Mn done by WC.

[9] F is field measurement.

[10] temp, pH, do, Eh, and Rn obtained on 79-07-09; He, As, Pb, Hg, and Se on 80-08-25. Al and Fe done by WC; Li and Zn done by SPEC.

[11] temp, pH, do, Eh, and Rn obtained on 79-07-11.

[12] pH, Rn, As, Hg, and Se from Barrett and Pearl (1976).

[13] Rn, As, Ga, Ge, Hg, Se, V, and Zr from Barrett and Pearl (1976).

[14] All data except spc, Ra, and U from Mallory and Barnett (1973).

[15] As, Cd, Hg, Se, and Zn from Barrett and Pearl (1976). All other data except spc, Ra, and U from Mallory and Barnett (1973). Pb and Li done by SPEC.

[16] temp, pH, spc, Ra, U, Rn, and all major ions obtained on 77-06-20.

[17] temp, pH, spc, Ra and U obtained on 76-09-23; Eh, Rn, He, As, Pb, Hg, and Se obtained on 80-06-27; TDS, all major ions, and Ba obtained on 70-07-24.

[18] temp, pH, spc, Ra, U, and all major ions obtained on 75-05-20; Rn on 77-06-21; Eh on 80-06-26.

[19] temp, pH, spc, Ra, U, and all major ions obtained on 75-05-20; Eh, Rn, He, As, Pb, Hg, and Se on 80-06-26.

[20] Major ions and trace elements except As, Pb, Hg, and Se from Mallory and Barnett (1973).

[21] All data except temp, pH, and spc from Barrett and Pearl (1976).

[22] As, Cd, Hg, and Se from Barrett and Pearl (1976). All other data except temp, pH, and spc from Mallory and Barnett (1973) or V. Janzer (oral commun., 1976).

[23] Al done by WC; Pb and Li done by SPEC. As, Cd, Hg, Se, and Zn from Barrett and Pearl (1976). A value of 520 ug/L Sn was determined for this sample, but a value of <13 ug/L Sn was reported by Barrett and Pearl (1976); therefore, no Sn values are shown.

[24] temp, pH, spc, Eh, Rn, He, As, Pb, Hg, and Se obtained on 80-06-25; all other data except Ra and U on 75-07-26.

Table 2 footnotes: continued

[25] Rn, As, Cd, Hg, and Se from Barrett and Pearl (1976). All other data except temp and spc from Mallory and Barnett (1973) or V. Janzer (oral commun., 1976).

[26] All data from Mallory and Barnett (1973) or V. Janzer (oral commun., 1976).

[27] Ra and U from Scott and Voegeli (1961).

[28] Major ions from Young and Mitchell (1973).

[29] Eh and Rn obtained on 80-08-26.

[30] Eh, Rn, He, As, Pb, Hg, and Se obtained on 80-08-26. Al and Fe done by WC; Li and Zn done by SPEC.

[31] temp, pH, spc, Eh, Ra, U, Rn, all major ions, As, Hg, Pb, and Se obtained on 78-08-26; He on 80-08-21. Al and Fe done by WC; Li and Zn done by SPEC.

[32] do, Eh, and Rn obtained on 79-07-07.

[33] do, Eh, and Rn obtained on 79-07-01.

[34] do, Eh, and Rn obtained on 79-06-30.

[35] pH, Ra, U, and Rn from O'Connell and Kaufmann (1976).

[36] Ra, U, and Rn from O'Connell and Kaufmann (1976).

[37] pH and Rn from O'Connell and Kaufmann (1976).

[38] spc and Eh obtained on 80-08-27.

[39] spc, Eh, He, As, Pb, Hg, and Se obtained on 80-08-27. Mn done by WC.

[40] spc, Eh, He, As, Pb, Hg, and Se obtained on 80-08-27.

[41] temp, pH, spc, do, Eh, Ra, U, Rn, He, all major ions, As, Be, Pb, Hg, Se, and Zn obtained on 79-04-18. Al and Fe done by WC; Li done by SPEC; Be and Zn done by ICP.

[42] pH, spc, do, Eh, Ra, U, Rn, He, all major ions, As, Be, Pb, Hg, and Se obtained on 79-04-19.

[43] do, Eh, Rn, and He obtained on 80-07-30.

[44] do, Eh, Rn, He, and trace elements obtained on 80-07-30. Fe and Mn as well as Al, Ba, Be, B, Li, Mo, Sr, and Zn done by ICP.

Table 3.--Summary of radioactive parameters

[The anomaly threshold was determined by adding two geometric deviations to the geometric mean and converting back to the antilog value. Arbitrary values for values shown as below detection were used to compute the mean for most parameters. No mean is shown for parameters having >50 percent of the values below detection; instead, the lowest value above detection is shown in parentheses, and only the number of samples above detection is shown]

Parameter	Minimum	Maximum	Geometric mean	Number of samples	Anomaly threshold
Ra(pCi/L)---	<0.1	300	1.48	163	171
Ra228(pCi/L)	(2.4)	33	----	8	---
U(µg/L)-----	<.01	120	.26	163	48.1
Rn(pCi/L)---	<10	110,000	549	96	20,400
He(ppb)-----	-1300	13,000	725	35	10,000
REF---------	.0098	110,000	16.4	161	21,700
UEF---------	.00001	100	.062	161	78.3
Ra/spc------	.026	200	.78	163	27.6
U/spc-------	.00004	160	.14	163	36.6

Table 4.--Summary of nonradioactive parameters

[Arithmetic mean rather than geometric mean is shown for pH and Eh. Selected values for data below the detection limits were used to compute the mean for most parameters. No mean is shown for parameters having >50 percent of the values below detection; instead, the lowest value above the detection limit is shown in parentheses, and only the number of samples above the detection limit is shown. No values above the detection limit were reported for Sb, Bi, and La. Sn is discussed in table 2. Units of measurement are the same as those shown in table 2]

Parameter	Minimum	Maximum	Geometric mean	Number of samples
temp-------------	6	94	28.8	163
pH---------------	2.9	9.5	7.4	163
spc--------------	83	52,000	1910	163
TDS--------------	83	35,000	1250	123
do---------------	<.05	11.5	2.25	53
Eh---------------	-580	270	-18	73
SiO_2------------	1.3	270	34.1	124
Ca---------------	.8	930	61.2	124
Mg---------------	<.1	330	10.7	124
Na---------------	4.8	15,000	240	124
K----------------	.8	870	16.4	124
HCO_3+CO_3---------	<1	4,330	308	124
SO_4--------------	5.9	2,800	136	124
Cl---------------	.7	26,000	128	124
F----------------	.1	17	1.56	124
NO_3+NO_2----------	<.01	4.9	.040	123
PO_4--------------	<.01	.77	.052	70
Al---------------	<10	10,000	42.2	127
As---------------	<1	1,000	6.1	76
Ba---------------	<2.4	7,600	60.4	127
Be---------------	(.1)	26	---	25
B----------------	<5	23,000	368	127
Cd---------------	(1)	1	---	3
Cr---------------	(.94)	38	---	8
Co---------------	(.2)	6.9	---	20
Cu---------------	(.65)	40	---	25
Ga---------------	(1.2)	14	---	7
Ge---------------	(4.9)	15	---	7
Fe---------------	<10	47,000	50.8	127
Pb---------------	<1	230	1.1	74

Table 4.--Summary of nonradioactive parameters - continued

Parameter	Minimum	Maximum	Geometric mean	Number of samples
Li---------------	<10	14,000	321	127
Mn---------------	<1	1,800	19.5	127
Hg---------------	(.1)	9.0	---	8
Mo---------------	<.4	760	7.7	125
Nd---------------	(2,000)	2,000	---	1
Ni---------------	(1)	15	---	5
Sc---------------	(.45)	3.6	---	5
Se---------------	(1)	5	---	14
Ag---------------	(.02)	1	---	6
Sr---------------	2.6	38,000	1030	127
W----------------	(51)	190	---	5
V----------------	(2.3)	20	---	4
Yb---------------	(.02)	2.4	---	9
Y----------------	(.29)	20	---	17
Zn---------------	<5	700	5.4	97
Zr---------------	(5)	57	---	7

Table 5.—Matrix of correlation coefficients for all parameters

[Matrix is based on all samples. Underline designates correlation significant at 95-percent level. Asterisk designates parameter not used in factor analysis. Numbers below diagonal are numbers of valid pairs of data for the corresponding correlation coefficients above diagonal]

	pH	Eh mv	temp log	spc log	TDSs log *	TDSR log *	DO log *	Ra log	Ra228log *	U log
pH	0.7861	0.0235	0.0938	-0.3936	-0.3826	-0.4174	-0.0684	-0.5061	-0.6340	-0.2140
Eh mv	73	174.7237	-0.3735	-0.4757	-0.4976	-0.3364	0.5283	-0.3558	-0.3826	0.4840
temp log	160	73	0.3156	0.1360	0.1696	-0.2839	-0.6444	0.2637	0.2759	-0.6094
spc log	160	73	163	0.5652	0.9907	0.9848	-0.4404	0.6722	-0.5544	0.0915
TDSs log *	123	72	123	123	0.5876	0.9914	-0.5184	0.6577	-0.5141	0.0851
TDSR log *	45	19	45	45	44	0.5144	-0.4871	0.5168	***********	0.3003
DO log *	52	44	53	53	49	15	0.6744	-0.3365	***********	0.4650
Ra log	160	73	163	163	123	45	53	1.0311	0.9293	-0.0365
Ra228log *	8	6	8	8	8	1	1	8	0.4182	0.1778
U log	160	73	163	163	123	45	53	163	8	1.1325
Rn log *	96	73	96	96	84	22	44	96	8	96
He log *	35	35	35	35	34	13	25	35	1	35
SiO2 log	124	72	124	124	123	45	49	124	8	124
Ca log	124	72	124	124	123	45	49	124	8	124
Mg log	124	72	124	124	123	45	49	124	8	124
Na log	124	72	124	124	123	45	49	124	8	124
K log	124	72	124	124	123	45	49	124	8	124
HCOCOlog	124	72	124	124	123	45	49	124	8	124
SO4 log	124	72	124	124	123	45	49	124	8	124
Cl log	124	72	124	124	123	45	49	124	8	124
F log	130	73	130	130	123	45	50	130	8	130
NO3 log	123	72	123	123	123	44	49	123	8	123
PO4 log *	70	21	70	70	70	43	15	70	1	70
alk log *	116	68	116	116	115	37	49	116	8	116
hrd log *	123	72	123	123	123	44	49	123	8	123
Al log	127	73	127	127	123	45	50	127	8	127
As log *	76	65	76	76	74	17	38	76	8	76
Ba log	127	73	127	127	123	45	50	127	8	127
Be log *	25	16	25	25	24	16	6	25	5	25
B log	127	73	127	127	123	45	50	127	8	127
Cr log *	8	2	8	8	8	7	3	8	1	8
Co log *	20	6	20	20	20	20	11	20	1	20
Cu log *	25	7	25	25	24	21	9	25	1	25
Ga log *	7	3	7	7	7	6	3	7	1	7
Ge log *	7	1	7	7	7	7	2	7	0	7
Fe log	127	73	127	127	123	45	50	127	8	127
Pb log *	74	65	74	74	72	19	38	74	8	74
Li log	127	73	127	127	123	45	50	127	8	127
Mn log	127	73	127	127	123	45	50	127	8	127
Hg log *	8	8	8	8	8	3	6	8	0	8
Mo log	125	73	125	125	121	45	50	125	8	125
Ni log *	5	3	5	5	5	5	0	5	0	5
Sc log *	5	1	5	5	5	4	2	5	0	5
Se log *	14	14	14	14	14	0	8	14	0	14
Ag log *	6	0	6	6	6	6	2	6	0	6
Sr log	127	73	127	127	123	45	50	127	8	127
W log *	5	3	5	5	5	5	3	5	0	5
V log *	4	0	4	4	4	3	2	4	0	4
Yb log *	9	4	9	9	9	9	5	9	0	9
Y log *	17	5	17	17	16	17	9	17	1	17
Zn log *	97	61	97	97	94	15	39	97	8	97
Zr log *	7	5	7	7	7	6	1	7	0	7

THE DIAGONAL OF THE CORR MATRIX CONTAINS THE STD DEV OF THE VARIABLE FOR ONLY THE VALID PAIRS.

Table 5.--Matrix of correlation coefficients for all parameters--Continued

	Rn log *	He log *	SiO2 log	Ca log	Mg log	Na log	K log	HCOCOlog	SO4 log	Cl log
pH	0.0071	-0.0546	0.0380	-0.5807	-0.6319	-0.2510	-0.3806	-0.0970	-0.3120	-0.2509
Eh mv	-0.2240	-0.2278	-0.3007	0.0122	0.1175	-0.6045	-0.5459	-0.2975	-0.2518	-0.3820
temp log	0.2895	0.3675	0.5512	-0.1157	-0.3626	0.2486	0.2958	0.0534	0.3281	0.0211
spc log	0.1619	0.4302	-0.1028	0.7118	0.5844	0.9181	0.8858	0.3985	0.6170	0.9317
TDSs log *	0.2171	0.3985	-0.0336	0.6877	0.5484	0.9274	0.8917	0.3705	0.6477	0.9143
TDSR log *	-0.2206	0.4144	-0.2661	0.7184	0.7214	0.9501	0.8871	0.2885	0.5849	0.9284
DO log *	-0.1681	-0.4316	-0.4529	-0.0534	0.0446	-0.5708	-0.6424	-0.2363	-0.4438	-0.3047
Ra log	0.4072	0.3114	-0.0152	0.6101	0.5317	0.5900	0.7079	0.4390	0.3903	0.5399
Ra228log *	0.6430	***********	-0.0340	0.0684	0.0658	-0.6042	-0.4330	-0.0592	-0.4532	-0.7383
U log	-0.0684	-0.3460	-0.3732	0.3469	0.5149	0.0053	-0.0109	0.0400	-0.0222	0.2128
Rn log *	0.7854	-0.0171	0.2147	-0.0064	-0.1521	0.2721	0.2257	-0.0303	0.0985	0.1305
He log *	35	0.1130	-0.0185	0.6101	0.2254	0.3280	0.4146	-0.2201	0.2464	0.3648
SiO2 log	85	34	0.3693	-0.3225	-0.3656	0.0442	0.1041	-0.0402	0.0955	-0.1727
Ca log	85	34	124	0.6897	0.8705	0.4506	0.5711	0.2397	0.4864	0.6226
Mg log	85	34	124	124	1.0357	0.3325	0.4976	0.3509	0.2748	0.5322
Na log	85	34	124	124	124	0.8047	0.8689	0.3828	0.5777	0.9051
K log	85	34	124	124	124	124	0.7038	0.4163	0.5619	0.8015
HCOCOlog	85	34	124	124	124	124	124	0.5069	0.1176	0.3534
SO4 log	85	34	124	124	124	124	124	124	0.5997	0.5009
Cl log	85	34	124	124	124	124	124	124	124	1.0596
F log	89	35	124	124	124	124	124	124	124	124
NO3 log	84	34	123	123	123	123	123	123	123	123
PO4 log *	31	14	70	70	70	70	70	70	70	70
alk log *	81	30	116	116	116	116	116	116	116	116
hrd log *	84	34	123	123	123	123	123	123	123	123
Al log	86	35	124	124	124	124	124	124	124	124
As log *	74	34	75	75	75	75	75	75	75	75
Ba log	86	35	124	124	124	124	124	124	124	124
Be log *	20	9	25	25	25	25	25	25	25	25
B log	86	35	124	124	124	124	124	124	124	124
Cr log *	3	2	8	8	8	8	8	8	8	8
Co log *	6	3	20	20	20	20	20	20	20	20
Cu log *	13	4	25	25	25	25	25	25	25	25
Ga log *	4	1	7	7	7	7	7	7	7	7
Ge log *	1	0	7	7	7	7	7	7	7	7
Fe log	86	35	124	124	124	124	124	124	124	124
Pb log *	70	34	73	73	73	73	73	73	73	73
Li log	86	35	124	124	124	124	124	124	124	124
Mn log	86	35	124	124	124	124	124	124	124	124
Hg log *	6	6	8	8	8	8	8	8	8	8
Mo log	85	35	122	122	122	122	122	122	122	122
Ni log *	4	3	5	5	5	5	5	5	5	5
Sc log *	2	0	5	5	5	5	5	5	5	5
Se log *	14	7	14	14	14	14	14	14	14	14
Ag log *	0	0	6	6	6	6	6	6	6	6
Sr log	86	35	124	124	124	124	124	124	124	124
W log *	3	0	5	5	5	5	5	5	5	5
V log *	0	0	4	4	4	4	4	4	4	4
Yb log *	4	3	9	9	9	9	9	9	9	9
Y log *	6	3	17	17	17	17	17	17	17	17
Zn log *	73	29	94	94	94	94	94	94	94	94
Zr log *	6	4	7	7	7	7	7	7	7	7

THE DIAGONAL OF THE CORR MATRIX CONTAINS THE STD DEV OF THE VARIABLE FOR ONLY THE VALID PAIRS.

Table 5.--Matrix of correlation coefficients for all parameters--Continued

	F log	NO3 log	PO4 log *	alk log*	hrd log *	Al log	As log*	Ba log	Be log *	B log
pH	0.1305	0.0334	0.0424	-0.0237	-0.6128	-0.3809	-0.1317	-0.3755	-0.4316	-0.1787
EH mv	-0.5771	0.3993	-0.4062	-0.3155	0.0222	0.0017	-0.4712	-0.1828	0.2942	-0.5461
temp log	0.7092	-0.5440	0.2338	0.1407	-0.1934	-0.2657	0.4835	0.0255	-0.2507	0.3373
spc log	0.1803	-0.1311	0.2378	0.3753	0.7082	0.3693	0.3983	0.4265	0.5719	0.7599
TDSs log *	0.2279	-0.1563	0.2520	0.3433	0.6814	0.3483	0.4051	0.3858	0.5264	0.7518
TDSR log *	-0.2767	-0.0034	0.0177	0.2220	0.7516	0.4401	0.3692	0.3333	0.6408	0.6867
DO log *	-0.5282	0.4488	0.0531	-0.2537	-0.0321	0.3299	-0.5933	-0.1528	0.8984	-0.4786
Ra log	0.2549	-0.3424	0.1880	0.4032	0.6047	0.1033	0.5194	0.5881	0.3088	0.5538
Ra228log *	-0.2054	-0.3420	***********	-0.0598	0.0642	-0.5615	0.5529	0.0560	0.7017	-0.5610
U log	-0.5241	0.4787	-0.0967	-0.0733	0.4153	0.3245	-0.1686	0.0371	0.6437	-0.0612
Rn log *	0.3389	-0.1567	-0.1265	-0.0713	-0.0290	0.0404	0.2479	0.0974	-0.3250	0.1437
He log *	0.1333	-0.1439	0.4263	-0.1606	0.5135	0.2728	0.2099	0.1707	-0.2123	0.1896
SiO2 log	0.5177	-0.2583	0.1300	-0.0513	-0.3357	-0.1875	0.3896	-0.1566	-0.0574	0.1356
Ca log	-0.2449	-0.0022	0.1876	0.2305	0.9881	0.3715	0.0912	0.5134	0.3519	0.3304
Mg log	-0.4275	0.1789	0.0875	0.3067	0.9226	0.4171	0.0261	0.5110	0.5543	0.2257
Na log	0.4039	-0.1922	0.1761	0.3616	0.4428	0.2497	0.4798	0.3205	0.4574	0.8095
K log	0.3217	-0.2144	0.2738	0.3903	0.5671	0.2625	0.5473	0.3987	0.4762	0.7438
HCCOlog	0.2009	-0.2369	0.0000	0.9960	0.2742	-0.1129	0.3095	0.3506	0.1214	0.4662
SO4 log	0.3690	-0.3687	0.1794	0.1256	0.4450	0.1952	0.4804	-0.0932	0.2244	0.5616
Cl log	0.1360	-0.0048	0.1584	0.3294	0.6285	0.3378	0.2386	0.3656	0.4525	0.7207
F log	0.6066	-0.5825	0.1030	0.2135	-0.2943	-0.2757	0.4884	-0.0320	-0.2105	0.5153
NO3 log	123	0.9470	-0.1218	-0.2604	0.0526	0.2787	-0.4111	-0.0630	0.3444	-0.2644
PO4 log *	70	70	0.7669	0.0788	0.1575	0.2183	0.1725	0.0370	0.1222	0.3474
alk log *	116	115	62	0.4869	0.2382	-0.1676	0.2758	0.3652	-0.0948	0.4422
hrd log *	123	123	70	115	0.7282	0.3974	0.0720	0.5220	0.4540	0.3262
Al log	125	123	70	116	123	0.6427	-0.0526	0.0663	0.3269	0.0774
As log*	76	74	21	71	74	76	0.9015	0.0399	-0.0133	0.5944
Ba log	125	123	70	116	123	127	76	0.6793	0.0824	0.2851
Be log*	25	24	16	20	24	25	18	25	0.5673	0.3678
B log	125	123	70	116	123	127	76	127	25	0.8237
Cr log*	8	8	8	8	8	8	3	8	4	8
Co log*	20	20	20	20	20	20	3	20	6	20
Cu log*	25	24	24	24	24	25	9	25	5	25
Ga log*	7	7	7	7	7	7	2	7	1	7
Ge log*	7	7	7	7	7	7	0	7	4	7
Fe log	125	123	70	116	123	127	76	127	25	127
Pb log*	74	72	19	67	72	74	71	74	18	74
Li log	125	123	70	116	123	127	76	127	25	127
Mn log	125	123	70	116	123	127	76	127	25	127
Hg log*	8	8	3	8	8	8	8	8	2	8
Mo log	123	121	68	114	121	125	74	125	25	125
Ni log*	5	5	5	2	5	5	4	5	4	5
Sc log*	5	5	5	5	5	5	1	5	1	5
Se log*	14	14	0	14	14	14	14	14	1	14
Ag log*	6	6	6	3	6	6	1	6	1	6
Sr log	125	123	70	116	123	127	76	127	25	127
W log*	5	5	5	5	5	5	0	5	1	5
V log*	4	4	4	4	4	4	0	4	0	4
Yb log *	9	9	9	9	9	9	3	9	3	9
Y log *	17	16	16	17	16	17	4	17	5	17
Zn log*	95	94	41	93	94	97	69	97	13	97
Zr log*	7	7	7	4	7	7	5	7	5	7

THE DIAGONAL OF THE CORR MATRIX CONTAINS THE STD DEV OF THE VARIABLE FOR ONLY THE VALID PAIRS.

Table 5.--Matrix of correlation coefficients for all parameters--Continued

	Cr log *	Co log *	Cu log *	Ga log *	Ge log *	Fe log	Pb log *	Li log	Mn log	Hg log *
pH	-0.5143	-0.3375	-0.5179	0.4996	0.0957	-0.5106	-0.1129	-0.2201	-0.4444	-0.0901
Eh mv	1.0000	-0.3068	-0.0414	0.8804	***********	-0.2850	-0.2510	-0.5903	-0.4358	0.3914
temp log	-0.3157	0.0236	-0.4439	0.3663	0.6004	0.1454	0.3572	0.4858	0.3224	-0.4090
spc log	0.7479	0.9622	0.8698	-0.1005	0.5109	0.5503	0.0525	0.7616	0.6050	0.2440
TDSs log *	0.7675	0.9493	0.8933	0.1311	0.6146	0.5661	0.1089	0.7707	0.6034	0.1877
TDSR log *	0.9148	0.9647	0.8634	0.1375	0.6272	0.4657	0.0203	0.6275	0.3542	0.0019
DO log*	0.9718	0.0435	0.1758	-0.1751	1.0000	-0.4085	0.1462	-0.6045	-0.5268	0.3892
Ra log	0.0682	0.4812	0.4051	-0.8891	-0.0740	0.5462	0.1513	0.6229	0.5485	0.1476
Ra228log*	*********	***********	***********	***********	***********	0.1950	-0.8876	-0.0919	-0.6267	***********
U log	0.2912	0.0931	0.4375	-0.4379	-0.4168	0.0470	-0.2619	-0.1556	-0.2003	0.5265
Rn log*	-0.9957	-0.5690	-0.4289	-0.6506	***********	0.1218	0.2947	0.2563	-0.0298	0.6021
He log*	-0.9996	-0.8335	0.3882	***********	***********	0.3799	-0.0595	0.3151	0.3700	0.2854
SiO2 log	0.1666	0.1097	-0.2397	0.6547	0.6549	0.0614	0.3323	0.2244	0.0434	-0.3504
Ca log	0.5820	0.6158	0.6699	-0.8652	-0.1465	0.4644	-0.0980	0.3406	0.5286	0.2601
Mg log	0.4080	0.5817	0.6492	-0.5982	0.2163	0.3923	-0.2148	0.1880	0.3454	0.1346
Na log	0.6161	0.8373	0.7915	0.5845	0.5426	0.4464	0.1420	0.8299	0.5496	0.1460
K log	0.7572	0.8386	0.7587	0.2920	0.6368	0.5653	0.2142	0.8086	0.5678	0.0594
HCOCOlog	-0.5851	0.5114	-0.0577	0.1770	0.2229	0.1456	-0.1066	0.4510	0.2440	-0.0964
SO4 log	0.8077	0.7087	0.7025	-0.0453	0.7120	0.5219	0.1649	0.5707	0.5427	-0.0717
Cl log	0.6465	0.8391	0.7536	0.4603	0.6490	0.3752	-0.0782	0.6765	0.4565	0.2368
F log	-0.3510	0.3062	-0.2635	0.8023	0.1999	0.1971	0.3075	0.6225	0.3386	-0.2588
NO3 log	0.6089	0.0802	0.2901	-0.2223	0.3622	-0.2472	-0.2135	-0.3932	-0.3862	0.5960
PO4 log*	0.6964	0.3105	0.3651	0.1721	0.9430	0.1884	0.5019	0.3735	0.2544	-0.2334
alk log*	-0.5872	0.4989	-0.1612	0.2087	0.2928	0.0764	-0.1108	0.4223	0.3284	-0.1432
hrd log*	0.5721	0.6115	0.6916	-0.8576	-0.1244	0.4632	-0.1296	0.3203	0.4819	0.2248
Al log	0.5536	-0.2165	0.4959	0.8249	0.5474	0.3126	0.0132	0.0526	0.1578	0.5259
As log *	-0.4260	0.9969	0.5100	-1.0000	***********	0.3700	0.2840	0.6488	0.4029	-0.5936
Ba log	0.1399	0.4810	0.2714	-0.7315	-0.2555	0.1147	0.1644	0.2942	0.4209	-0.0468
Be log *	0.9009	0.7014	0.7763	***********	-0.5875	0.5106	-0.1875	0.2742	-0.0830	1.0000
B log	0.7976	0.8873	0.7480	-0.0257	0.5377	0.3931	0.1525	0.6711	0.5409	0.0138
Cr log *	0.6485	0.9519	0.9334	-1.0000	-1.0000	0.3494	0.8480	0.2669	0.5734	***********
Co log *	6	0.3840	0.9419	-0.1685	0.6583	0.3000	0.6992	0.8583	0.4829	***********
Cu log *	6	14	0.4858	-0.0557	0.7068	0.6623	0.5889	0.6704	0.5656	***********
Ga log *	2	5	6	0.3444	0.4104	-0.0650	***********	0.3947	-0.3013	***********
Ge log *	2	7	3	3	0.1943	0.6450	***********	0.6433	-0.4560	***********
Fe log	8	20	25	7	7	0.8330	0.1331	0.4849	0.5510	0.5628
Pb log *	4	4	7	1	0	74	0.7968	0.2470	0.2053	0.1958
Li log	8	20	25	7	7	127	74	0.9259	0.6004	-0.0460
Mn log	8	20	25	7	7	127	74	127	0.9780	0.2778
Hg log *	0	0	0	0	0	8	8	8	8	0.8109
Mo log	8	20	24	6	7	125	74	125	125	8
Ni log *	1	0	1	0	0	5	3	5	5	0
Sc log *	1	3	3	2	3	5	0	5	5	0
Se log *	0	0	0	0	0	14	14	14	14	2
Ag log *	0	2	2	0	0	6	3	6	6	0
Sr log	8	20	25	7	7	127	74	127	127	8
W log *	1	3	2	3	2	5	0	5	5	0
V log *	0	3	2	1	1	4	0	4	4	0
Yb log *	2	7	6	2	2	9	4	9	9	1
Y log *	6	14	11	3	5	17	5	17	17	0
Zn log *	4	2	10	2	0	97	64	97	97	8
Zr log *	2	2	4	1	2	7	4	7	7	0

THE DIAGONAL OF THE CORR MATRIX CONTAINS THE STD DEV OF THE VARIABLE FOR ONLY THE VALID PAIRS.

Table 5.--Matrix of correlation coefficients for all parameters--Continued

	Mo log	Ni log*	Sc log *	Se log *	Ag log *	Sr log	W log*	V log *	Yb log *	Y log*
pH	0.1816	-0.5797	-0.9667	-0.3279	-0.7823	-0.4905	-0.4015	-0.0751	-0.3479	-0.4588
Eh mv	-0.2937	0.7723	***********	0.0214	***********	-0.2877	-0.4165	***********	-0.2066	0.3652
temp log	0.3398	0.2783	-0.2169	-0.0923	-0.0949	0.1289	-0.2666	0.2132	0.2917	-0.2777
spc log	0.3283	-0.8177	0.9727	0.4483	0.8887	0.8459	0.7163	0.6897	0.9802	0.9279
TDSs log *	0.3401	-0.8207	0.9878	0.4846	0.8178	0.8352	0.6112	0.6421	0.9786	0.9337
TDSR log *	0.1069	-0.8205	0.9958	***********	0.7998	0.7991	0.6025	0.9987	0.9797	0.9355
DO log *	-0.3057	***********	1.0000	-0.0719	-1.0000	-0.2379	0.9570	-1.0000	-0.8351	-0.0573
Ra log	0.2522	0.1895	0.7669	0.1103	0.8397	0.7285	0.8177	0.9412	0.8239	0.3862
Ra228log *	-0.4593	***********	***********	***********	***********	-0.1427	***********	***********	***********	***********
U log	-0.0847	0.4394	0.7807	0.3869	-0.2910	0.1718	-0.1587	-0.2682	-0.1594	0.3137
Rn log *	0.3530	-0.4563	-1.0000	-0.0766	***********	0.2590	0.5940	***********	0.0110	-0.9757
He log *	0.4788	0.6883	***********	-0.3850	***********	0.4218	***********	***********	0.7870	0.0179
SiO2 log	0.1125	0.9179	-0.3786	0.0820	-0.6843	-0.1550	-0.1482	-0.2688	-0.0125	-0.1968
Ca log	0.1520	-0.7742	0.8762	0.4619	0.7394	0.8411	0.4621	0.6445	0.8539	0.6095
Mg log	-0.0804	-0.3978	0.8918	0.2721	0.8120	0.6676	0.5190	0.6668	0.6906	0.5981
Na log	0.3304	-0.8126	0.9531	0.2939	0.8565	0.7135	0.6773	0.1985	0.9623	0.7992
K log	0.2921	-0.5505	0.8333	0.2928	0.8118	0.7383	0.1707	0.6327	0.8490	0.8272
HCOCOlog	-0.0190	-0.2727	0.5105	-0.1969	0.7547	0.3448	-0.0073	0.6220	0.0030	-0.0881
SO4 log	0.2946	-0.4258	0.8391	0.6224	0.6706	0.6382	0.2446	0.9041	0.8400	0.8237
Cl log	0.2624	-0.8015	0.8666	0.3694	0.8792	0.7440	0.6055	0.4737	0.9166	0.7381
F log	0.2773	0.5509	-0.6984	-0.1536	0.1867	0.1346	0.6577	0.3933	0.1488	0.0852
NO3 log	-0.1711	0.5921	0.3343	0.3576	-0.5895	-0.2057	-0.1289	-0.7981	-0.4127	0.1249
PO4 log *	0.4303	0.5137	-0.7409	***********	-0.9204	0.1271	0.2372	-0.0664	0.3410	0.3355
alk log *	0.0085	-1.0000	0.4707	-0.2491	0.9744	0.3271	-0.1024	0.5158	0.0093	-0.0811
hrd log *	0.1050	-0.7272	0.8720	0.4128	0.7681	0.8206	0.4649	0.6333	0.8346	0.5695
Al log	0.0976	0.3527	-0.3694	0.2452	0.2157	0.3058	-0.2386	-0.3313	-0.0387	0.5761
As log *	0.4083	-0.2400	***********	-0.2419	***********	0.3981	***********	***********	0.0594	0.0421
Ba log	0.0438	0.2820	0.4911	-0.0572	0.8232	0.5356	0.3644	0.8004	0.7430	0.3029
Be log *	-0.0356	0.2723	***********	***********	***********	0.3966	***********	***********	-0.9397	0.9572
B log	0.2994	0.2207	0.5082	0.4351	0.7586	0.5782	0.6798	0.3995	0.7974	0.7742
Cr log *	0.1874	***********	***********	***********	***********	0.6746	***********	***********	1.0000	0.9486
Co log *	0.1543	***********	0.9998	***********	1.0000	0.8217	0.7929	0.9941	0.9415	0.9651
Cu log *	0.1239	***********	0.9924	***********	1.0000	0.6923	1.0000	1.0000	0.8767	0.9512
Ga log *	-0.4378	***********	1.0000	***********	***********	-0.6720	-0.6615	***********	1.0000	0.2293
Ge log *	-0.4911	***********	0.5872	***********	***********	-0.1473	-1.0000	***********	1.0000	0.8463
Fe log	0.2325	0.4845	0.9822	0.4697	0.4898	0.5263	0.2109	0.6439	0.3637	0.5685
Pb log *	0.3244	0.9384	***********	0.2539	0.2840	0.1532	***********	***********	-0.7219	0.4988
Li log	0.3144	0.3920	0.9164	-0.2175	0.6548	0.6170	0.7197	0.5091	0.8420	0.6675
Mn log	0.1528	-0.0709	0.6555	0.3958	0.7864	0.6085	0.5925	0.8731	0.7598	0.7297
Hg log *	0.1226	***********	***********	1.0000	***********	0.1792	***********	***********	***********	***********
Mo log	0.8175	0.5367	0.1143	0.5121	-0.4563	0.3245	-0.1171	0.5501	0.2326	0.0324
Ni log *	5	0.4469	***********	***********	***********	-0.9432	***********	***********	***********	***********
Sc log *	5	0	0.3280	***********	***********	0.8916	***********	***********	1.0000	0.9964
Se log *	14	0	0	0.2439	***********	0.5031	***********	***********	***********	***********
Ag log *	6	1	0	0	0.6618	0.8421	***********	1.0000	***********	***********
Sr log	125	5	5	14	6	0.7816	0.4850	0.8881	0.8709	0.7652
W log *	5	0	1	0	0	5	0.2088	***********	***********	-0.2488
V log *	4	0	0	0	2	4	1	0.3852	***********	1.0000
Yb log *	9	1	2	0	1	9	1	1	0.6112	0.8678
Y log *	17	1	3	0	1	17	3	2	7	0.4935
Zn log *	95	2	1	14	1	97	0	1	2	3
Zr log *	7	3	2	0	0	7	0	0	1	2

THE DIAGONAL OF THE CORR MATRIX CONTAINS THE STD DEV OF THE VARIABLE FOR ONLY THE VALID PAIRS.

Table 5.--Matrix of correlation coefficients for all parameters--Continued

	Zn log *	Zr log *
pH	-0.3846	-0.0505
Eh mv	0.0030	-0.0901
temp log	0.0880	-0.0590
spc log	0.4627	0.4576
TDSs log *	0.4777	0.5308
TDSR log *	0.2938	0.5809
DO log *	-0.2340	***********
Ra log	0.4203	0.5300
Ra228log *	0.6816	***********
U log	0.0829	0.2943
Rn log *	0.1633	0.4027
He log *	0.3707	-0.4844
SiO2 log	-0.1032	-0.3680
Ca log	0.4264	0.3153
Mg log	0.3492	0.3765
Na log	0.3713	0.4678
K log	0.3855	0.5527
HCOCOlog	-0.1528	0.2181
SO4 log	0.3322	0.2739
Cl log	0.3215	0.3870
F log	0.0242	-0.2035
NO3 log	-0.1675	0.4356
PO4 log *	0.4883	-0.2248
alk log *	-0.1491	0.2123
hrd log *	0.4186	0.4077
Al log	0.2769	-0.0025
As log *	0.1303	0.8702
Ba log	0.2584	0.2780
Be log *	0.4471	0.5733
B log	0.2243	0.6313
Cr log *	0.8480	1.0000
Co log *	1.0000	1.0000
Cu log *	0.7460	0.5159
Ga log *	-1.0000	***********
Ge log *	*********	-1.0000
Fe log	0.5278	0.2924
Pb log *	0.0799	0.3605
Li log	0.3695	0.6081
Mn log	0.4779	0.1308
Hg log *	0.1873	***********
Mo log	0.3662	0.4587
Ni log *	1.0000	0.0042
Sc log *	*********	1.0000
Se log *	0.1652	***********
Ag log *	*********	***********
Sr log	0.4243	0.3524
W log *	*********	***********
V log *	*********	***********
Yb log *	-1.0000	***********
Y log *	0.9692	-1.0000
Zn log *	0.6759	-1.0000
Zr log *	2	0.3550

THE DIAGONAL OF THE CORR MATRIX CONTAINS THE STD DEV OF THE VARIABLE FOR ONLY THE VALID PAIRS.

Table 6.--Matrix of correlation coefficients for 24 parameters

[Matrix is based on 71 selected samples. Underline designates correlation significant at 95-percent level]

	pH	Eh mv	temp log	spc log	Ra log	U log	SiO2 log	Ca log	Mg log	Na log
pH	1.0000	0.0729	0.0910	-0.4038	-0.5454	-0.2963	-0.1156	-0.6559	-0.7251	-0.2575
Eh mv	0.0729	1.0000	-0.3632	-0.4784	-0.3540	0.4765	-0.3087	0.0048	0.1101	-0.6072
temp log	0.0910	-0.3632	1.0000	0.2037	0.3141	-0.6497	0.4819	-0.0942	-0.3847	0.3370
spc log	-0.4038	-0.4784	0.2037	1.0000	0.6675	0.0341	0.0776	0.6497	0.4932	0.9221
Ra log	-0.5454	-0.3540	0.3141	0.6675	1.0000	-0.0079	0.1902	0.5388	0.4711	0.5900
U log	-0.2963	0.4765	-0.6497	0.0341	-0.0079	1.0000	-0.2856	0.3305	0.5142	-0.1091
SiO2 log	-0.1156	-0.3087	0.4819	0.0776	0.1902	-0.2856	1.0000	-0.1777	-0.2402	0.2338
Ca log	-0.6559	0.0048	-0.0942	0.6497	0.5388	0.3305	-0.1777	1.0000	0.8476	0.3691
Mg log	-0.7251	0.1101	-0.3847	0.4932	0.4711	0.5142	-0.2402	0.8476	1.0000	0.2249
Na log	-0.2575	-0.6072	0.3370	0.9221	0.5900	-0.1091	0.2338	0.3691	0.2249	1.0000
K log	-0.4183	-0.5531	0.3205	0.8760	0.7053	-0.0720	0.2643	0.4761	0.4010	0.8770
HCOCOlog	-0.5660	-0.3293	-0.0868	0.5632	0.4926	0.2281	0.1106	0.3193	0.5123	0.5209
SO4 log	-0.2135	-0.2745	0.4916	0.6155	0.3604	-0.0981	0.1780	0.3817	0.0931	0.6459
Cl log	-0.3063	-0.3796	0.0417	0.9328	0.5181	0.1705	-0.0341	0.6009	0.4780	0.8780
F log	0.1064	-0.5738	0.7215	0.3712	0.3473	-0.5078	0.4812	-0.1715	-0.4268	0.5811
NO3 log	0.0444	0.3945	-0.6101	-0.2011	-0.3420	0.4538	-0.3413	0.0603	0.2886	-0.3237
Al log	-0.3600	-0.0184	-0.3367	0.3476	0.0761	0.3382	-0.2035	0.5264	0.5100	0.2139
Ba log	-0.4415	-0.1821	-0.0102	0.3915	0.5607	-0.0374	0.0065	0.4787	0.5167	0.2403
B log	-0.1299	-0.5452	0.3994	0.7774	0.5064	-0.1686	0.2645	0.2264	0.1063	0.8374
Fe log	-0.4551	-0.3609	0.2109	0.6584	0.6399	-0.0512	0.1154	0.4635	0.3615	0.6043
Li log	-0.2778	-0.5900	0.4999	0.8329	0.6177	-0.1935	0.3208	0.3062	0.1315	0.9051
Mn log	-0.3561	-0.4646	0.4161	0.5908	0.4653	-0.3120	0.2062	0.4710	0.2727	0.5646
Mo log	0.1975	-0.2956	0.5734	0.3268	0.2431	-0.4284	0.2768	0.0079	-0.3130	0.3887
Sr log	-0.5734	-0.2828	0.2259	0.8381	0.7173	0.0834	0.0479	0.7809	0.5500	0.7308

Table 6.--Matrix of correlation coefficients for 24 parameters--Continued

	K log	HCOCOlog	SO4 log	Cl log	F log	NO3 log	Al log	Ba log	B log	Fe log
pH	-0.4183	-0.5660	-0.2135	-0.3063	0.1064	0.0444	-0.3600	-0.4415	-0.1299	-0.4551
Eh mv	-0.5531	-0.3293	-0.2745	-0.3796	-0.5738	0.3945	-0.0184	-0.1821	-0.5452	-0.3609
temp log	0.3205	-0.0866	0.4916	0.0417	0.7215	-0.6101	-0.3367	-0.0102	0.3994	0.2109
spc log	0.8760	0.5632	0.6155	0.9328	0.3712	-0.2011	0.3476	0.3915	0.7774	0.6584
Ra log	0.7053	0.4926	0.3604	0.5181	0.3473	-0.3420	0.0761	0.5607	0.5064	0.6399
U log	-0.0720	0.2281	-0.0981	0.1705	-0.5078	0.4538	0.3382	-0.0374	-0.1686	-0.0512
SiO2 log	0.2643	0.1106	0.1780	-0.0341	0.4812	-0.3413	-0.2035	0.0065	0.2645	0.1154
Ca log	0.4761	0.3193	0.3817	0.6009	-0.1715	0.0603	0.5264	0.4787	0.2264	0.4635
Mg log	0.4010	0.5123	0.0931	0.4780	-0.4268	0.2886	0.5100	0.5167	0.1063	0.3615
Na log	0.8770	0.5209	0.6459	0.8780	0.5811	-0.3237	0.2139	0.2403	0.8374	0.6043
K log	1.0000	0.5266	0.5398	0.7624	0.4526	-0.2580	0.2348	0.3838	0.7147	0.6613
HCOCOlog	0.5266	1.0000	0.1903	0.4848	0.1575	-0.0845	0.0931	0.4447	0.5885	0.3881
SO4 log	0.5393	0.1903	1.0000	0.5299	0.5679	-0.4658	0.1151	-0.1601	0.6298	0.4507
Cl log	0.7624	0.4848	0.5299	1.0000	0.2801	-0.0638	0.3860	0.3188	0.7121	0.5292
F log	0.4526	0.1575	0.5679	0.2801	1.0000	-0.6646	-0.3162	-0.0398	0.6480	0.2754
NO3 log	-0.2580	-0.0845	-0.4658	-0.0638	-0.6646	1.0000	0.3640	0.0169	-0.4122	-0.2773
Al log	0.2349	0.0931	0.1151	0.3860	-0.3162	0.3640	1.0000	0.1273	-0.0324	0.2253
Ba log	0.3838	0.4447	-0.1601	0.3188	-0.0398	0.0169	0.1273	1.0000	0.2246	0.1972
B log	0.7147	0.5885	0.6298	0.7121	0.6480	-0.4122	-0.0324	0.2246	1.0000	0.4301
Fe log	0.6613	0.3881	0.4507	0.5292	0.2754	-0.2773	0.2253	0.1972	0.4301	1.0000
Li log	0.8428	0.5327	0.6904	0.7140	0.6887	-0.5132	0.0094	0.2248	0.8715	0.6142
Mn log	0.5592	0.3291	0.5251	0.4701	0.4180	-0.4719	0.0882	0.4263	0.5705	0.4889
Mo log	0.2987	-0.1742	0.4468	0.2111	0.5326	-0.4417	-0.0119	-0.0486	0.3332	0.3511
Sr log	0.7376	0.4222	0.6494	0.7568	0.3199	-0.2857	0.3998	0.4621	0.5735	0.6439

Table 6.--Matrix of correlation coefficients for 24 parameters--Continued

	Li log	Mn log	Mo log	Sr log
pH	-0.2778	-0.3561	0.1975	-0.5734
Eh mv	-0.5900	-0.4646	-0.2956	-0.2828
temp log	0.4999	0.4161	0.5734	0.2259
spc log	0.8329	0.5908	0.3266	0.8381
Ra log	0.6177	0.4653	0.2431	0.7173
U log	-0.1935	-0.3120	-0.4284	0.0834
SiO2 log	0.3208	0.2062	0.2768	0.0479
Ca log	0.3062	0.4710	0.0079	0.7809
Mg log	0.1315	0.2727	-0.3130	0.5500
Na log	0.9051	0.5646	0.3887	0.7308
K log	0.8428	0.5592	0.2987	0.7376
HCOCOlog	0.5327	0.3291	-0.1742	0.4222
SO4 log	0.6904	0.5251	0.4468	0.6494
Cl log	0.7140	0.4701	0.2111	0.7568
F log	0.6887	0.4180	0.5326	0.3199
NO3 log	-0.5132	-0.4719	-0.4417	-0.2857
Al log	0.0094	0.0882	-0.0119	0.3998
Ba log	0.2243	0.4263	-0.0486	0.4621
B log	0.8715	0.5705	0.3332	0.5735
Fe log	0.6142	0.4889	0.3511	0.6439
Li log	1.0000	0.6252	0.3733	0.6789
Mn log	0.6252	1.0000	0.2808	0.5952
Mo log	0.3733	0.2808	1.0000	.3526
Sr log	0.6789	0.5952	0.3526	1.0000

Table 7.--Reordered varimax factor matrix for 24 parameters

[Numbers are factor loadings. Communality is percentage of total variance accounted for by these three factors. A data matrix of 71 samples and 24 variables was used]

Parameter	Factor 1 Duration of circulation	Factor 2 Depth of circulation	Factor 3 Partial pressure of carbon dioxide	Communality
spc-------	0.89364	-0.00847	0 .38106	94
Na--------	.89201	.20889	.22317	89
Cl--------	.86215	- .16908	.26630	84
SO4-------	.80901	.18823	- .08908	70
Li--------	.80374	.40752	.26817	88
Sr--------	.78890	- .04991	.45407	83
K---------	.77298	.17765	.43196	82
B---------	.74400	.36603	.20653	73
Fe--------	.62903	.08420	.35731	53
Mn--------	.51857	.34942	.42714	57
Mo--------	.50831	.42424	- .29969	53
temp-----	0.30350	0.77935	-0.08892	71
F--------	.49020	.76621	- .10539	84
SiO2-----	.05579	.60972	.12818	39
Eh-------	-.42700	-.52285	- .17917	49
Al-------	.38087	-.62633	.10927	55
NO3NO$_2$---	-.27572	-.71708	- .03972	59
U--------	.00171	-.76168	.14895	60
Ba-------	0.03816	0.04661	0.80949	66
Mg-------	.25317	-.58173	.71439	91
HCO_3+CO_3-	.31167	.02133	.68051	56
Ra-------	.48332	.21481	.65867	71
Ca-------	.50748	-.43303	.55696	76
pH-------	-.19965	.18966	-.78317	69

Table 8.--Factor score matrix for 24 parameters and 71 samples

Sample	Factor 1 Duration of circulation	Factor 2 Depth of circulation	Factor 3 Partial pressure of carbon dioxide
Older, deeper water:			
CA 1	0.320	1.270	0.410
CA 4	.489	1.338	1.001
CA 5	.977	.950	.637
CA 10	.358	.003	1.063
CO 11	.584	.281	1.008
CO 22	.634	.682	.348
MT 2	.425	1.063	.832
MT 4	.109	1.180	.909
MT 6	.261	.958	.514
MT 11	.780	.383	.243
UT 9A	1.748	.241	1.791
UT 10	2.390	.121	.557
UT 18	1.940	.201	.549
UT 23	1.247	.324	.181
UT 36A	.352	.265	1.046
CA 9	.069	.983	- .436
MT 1	.829	.760	-2.539
MT 7	.051	1.711	-1.742
NV 24	.145	1.494	- .562
NV 25B	.227	.514	-2.503
NV 29	.763	.683	-1.629
NV 30	.704	.751	- .725
NV 32	.538	.679	-1.609
Younger, shallower water:			
CA 2	-1.470	- .676	- .374
CA 3	-1.991	- .686	- .171
CA 6	-1.152	- .609	- .483
CA 7	-1.443	- .608	-1.182
NV 21	- .430	- .694	- .390
NV 27	- .222	-1.143	- .419
NV 28	- .274	-1.165	- .050
UT 16	- .185	-1.318	- .139
UT 17	- .879	-1.045	- .051
UT 21	- .714	- .663	- .124
UT 26	-1.490	- .248	- .416
UT 28	- .490	-1.256	- .281
UT 30	- .326	-1.408	- .521

Table 8.--Factor score matrix for 24 parameters and 71 samples--continued

Sample	Factor 1 Duration of circulation	Factor 2 Depth of circulation	Factor 3 Partial pressure of carbon dioxide
Younger, shallower water--cont.:			
NV 16	-1.291	- .318	.038
NV 17	-1.542	- .580	.363
NV 20	-1.340	- .347	.537
NV 23	-1.016	- .059	.445
NV 31	- .585	- .218	.141
UT 25	- .688	- .597	.063
UT 29	- .366	- .730	.282
UT 32	- .804	-1.090	.672
UT 33	-1.352	- .817	.484
UT 34	- .304	- .439	.350
UT 35	- .698	- .955	.174
UT 39	-1.361	- .633	.473
Older, shallower water:[1]			
CO 14	0.714	-0.587	1.211
CO 15	1.082	- .554	1.476
UT 19	1.390	-2.018	.055
UT 22	.093	- .978	.001
CO 10	2.425	-1.170	- .122
MT 14	1.014	- .177	- .070
UT 6	2.059	-1.028	- .347
UT 20	1.718	-1.001	- .149
UT 24	.563	-1.928	- .727
UT 27	.691	- .770	- .306
UT 31	.476	- .800	- .314
UT 40	.435	-1.655	- .706
Younger, deeper water:[2]			
CO 12A	- .068	.379	2.323
MT 13	- .905	1.379	1.124
NV 5	- .723	1.653	2.097
NV 6A	- .735	1.089	1.293
NV 18	-1.790	1.646	2.040
CA 8	- .425	.524	-1.463
CO 17	- .180	1.205	- .233
MT 5	- .162	1.915	-1.505
MT 8	- .159	1.526	-2.009
MT 9	- .117	1.594	- .727
MT 12	- .927	1.223	-1.710

Table 8 footnotes:

[1] May be older, deeper water having abnormally low temperature or younger, shallower water having abnormally high salinity.

[2] May be older, deeper water having abnormally low salinity or younger, shallower water having abnormally high temperature.