

HYDROCHEMICAL DATA BASE FOR THE DEATH VALLEY REGION, CALIFORNIA AND NEVADA

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CONTENTS

Abstract	1
Introduction	1
Data sources	1
Presentation of data	2
Discussion/data limitations	6
Conventions used	6
Location accuracy	7
Methods used in computing cation-anion balances	8
Editing procedure	8
Data-base limitations	9
Summary	9
References cited	9

FIGURES

1. Map showing area of interest	1
2. Diagram showing lettering conventions used to define locations	2

TABLES

1. Abbreviations used in the "SITE NAME" column	3
2. Column headings for dissolved chemical species	4
3. Data sources and codes	5
4. Abbreviations used to define the laboratory which performed the chemical analysis	6
5. Abbreviations used in the "AQUIFER" column	6
6. Abbreviations used in the "LITHOLOGY" column	6
7. Abbreviations used in the "SAMPLE SOURCE" column	6
8. Abbreviations used in the "COMMENTS" column	7

CONVERSION FACTORS

Multiply metric unit	By	To obtain inch-pound unit
kilometer (km)	0.6214	mile
meter (m)	3.281	foot

Degree Celsius (°C) may be converted to degree Fahrenheit (°F) by using the following equation:

$$^{\circ}\text{F} = 9/5 (^{\circ}\text{C}) + 32.$$

Sea level: In this report "sea level" refers to the National Geodetic Vertical Datum of 1929 (NGVD of 1929)—a geodetic datum derived from a general adjustment of the first-order level nets of both the United States and Canada, formerly called Sea Level Datum of 1929.

Hydrochemical Data Base for the Death Valley Region, California and Nevada

By Diana L. Perfect, Claudia C. Faunt, William C. Steinkampf, and A. Keith Turner

Abstract

Ground-water chemistry data derived from samples collected within an approximately 100,000-square-kilometer area in the Southern Great Basin have been compiled into a digital data base. The data were compiled from published reports, the U.S. Geological Survey (USGS) National Water Information System (NWIS), and previously unpublished USGS files. The data are contained in two compressed files which self-expand into Lotus (.WK1) files. The first file contains 4,738 records (4.84 megabytes) and represents the basic compilation of all identified analyses. The second file is an edited version of the first and contains 3,733 records (3.84 megabytes). Editing included the removal of duplicate records and the combining of records, when appropriate. The analyses presented are of variable quality and comprehensiveness and include no isotopic data. Of the 3,733 analyses in the edited data base, 58 percent of the major ion concentrations balance to within ± 10 percent. Most of the remaining records are not sufficiently complete for a balance to be calculated.

INTRODUCTION

Yucca Mountain, Nevada, is being studied by the U.S. Department of Energy as a potential site for construction of a repository for the permanent storage of high-level radioactive waste. As part of this project, the USGS is engaged in studies to describe the site and the regional geologic and hydrogeologic systems. This compilation of ground-water chemistry data is a part of these studies.

The goal of this effort was to identify and compile existing hydrochemical data within a region bounded by lat 35°N to lat 38°N, and long 115°W to long 118°W. This region includes the Nevada Test Site, Yucca Mountain, and adjacent parts of southern Nevada and eastern California (fig. 1), and encompasses the Death Valley regional ground-water system (Bedinger and others, 1989). The data base was created to enable an assessment of existing data relative to

program needs, and to compile the data in a digital format for use in studies utilizing Geographic Information System (GIS) methods.

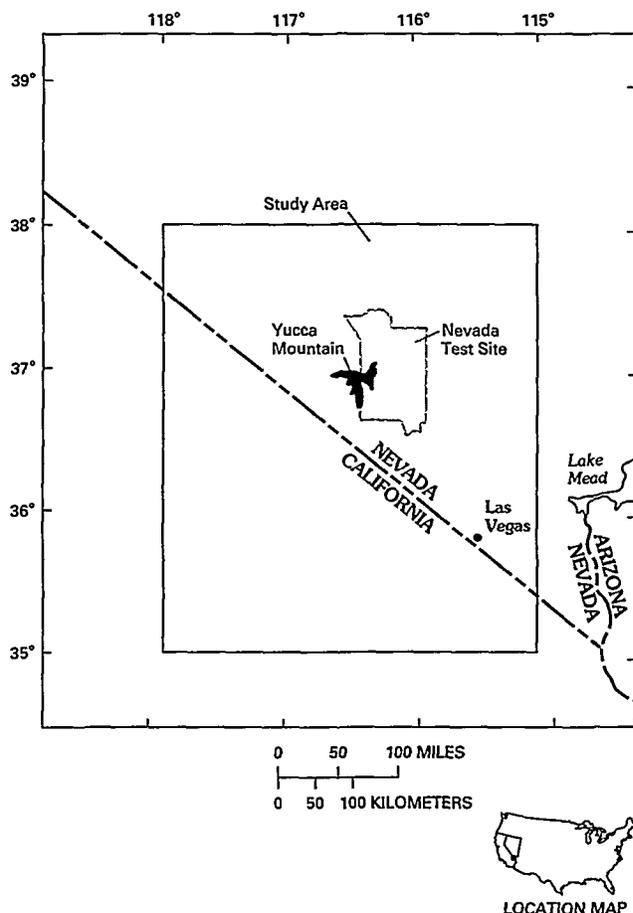


Figure 1. Area of interest.

DATA SOURCES

Data sources were located through a comprehensive literature search and by canvassing USGS investigators. The chemical analyses forming this data base were identified in four general sources: (1) USGS files of unpublished data, (2) the USGS National Water Information System (NWIS), (3) published reports of investigations by Federal and State agencies, and (4) unpublished data. The data base contains data from

44 different sources. Dates of the analyses range from 1910 to 1991. The following is a brief discussion of the data sources that provided most of the compiled information.

Data from over 1,800 original USGS laboratory reports were compiled. These data were collected as part of USGS hydrologic investigations in support of U.S. Department of Energy nuclear weapons testing and date from the early 1950's to the mid 1970's. While many of these were unpublished until now, some have been used in previously published USGS reports.

More than 1,300 analyses were retrieved from the NWIS data base for all available sites within the 3- by 3-degree area of interest (fig. 1) for inclusion in this compilation. Additional, unpublished data were obtained in digital form from Thomas and Welch (in press). Some of these records represent the arithmetic average of several analyses for the same sample site at which concentrations varied only slightly from one analysis to another.

PRESENTATION OF DATA

Two versions of the data base are available; both are files built using Lotus 1-2-3. The first, UNEDIT, is an unedited file which contains 4,738 records. The second, DATAEDIT, contains 3,733 records and is an edited version of the first. DATAEDIT primarily differs from UNEDIT in that most duplicate records have been removed, some of the records have been made more consistent, and cation-anion balances have been calculated. The information in this report pertains to DATAEDIT.

The files are on two high-density diskettes which accompany this report. They are both in compressed form and are self-expanding as indicated by the .EXE suffix. To expand DATAEDIT.EXE into a file retrievable by Lotus 1-2-3, copy it onto your hard drive and type <DATAEDIT>. The size of the expanded file, DATAEDIT.WK1, is 3.84 megabytes. To similarly expand UNEDIT.EXE, type <UNEDIT>. The size of this expanded file, UNEDIT.WK1, is 4.84 megabytes.

The following is a list of the data-base column headings in DATAEDIT. Column headings for UNEDIT are the same, except "BALANCE" is omitted.

1. **SITE NAME:** This is the name of the site as identified in the source(s) from which information was obtained. Names are presented in more than one format because different sources used different conventions and formats. In many cases, the site location given in the source, in terms of either township and

range or Nevada State coordinates, also is shown in this column. At least three different township-and-range conventions are used in the data base. One uses the standard abbreviations for quarter sections: NE (northeast), NW (northwest), SW (southwest), and SE (southeast). In another, each quarter of a quarter section is assigned a unique capital letter, starting with A in the northeast most and ending with R in the southeast most (fig. 2A). In a third convention, the lower-case letters a, b, c, and d are used to indicate the northeast, northwest, southwest, and southeast quarters, respectively (fig. 2B). Abbreviations used in this column are listed in table 1.

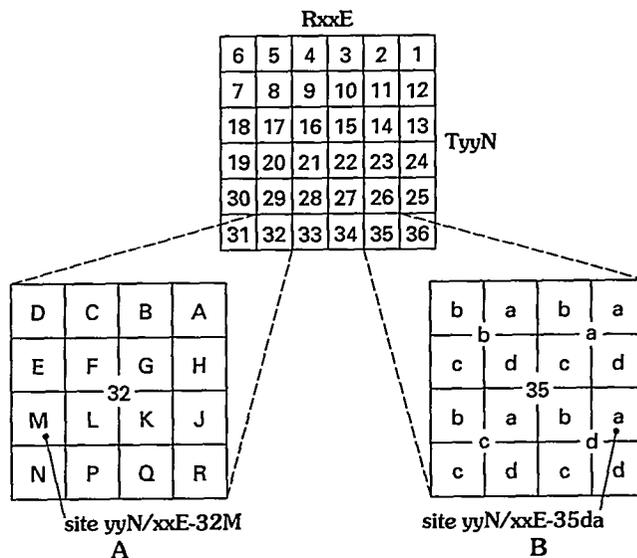


Figure 2. Diagram showing lettering conventions used to define locations.

2. **SITE ID:** This is an identifier assigned by the USGS to provide a unique means of identifying records within the NWIS. As such, this information is available only for records retrieved from the NWIS. The site identifier is a combination of the latitude and longitude and a two-digit sequence number. The sequence number enables identification of multiple sites with the same latitude and longitude coordinates. The actual latitude and longitude of a site can differ from that in the site identifier, particularly for those established before the 1970's. This is because

Table 1. Abbreviations used in the "SITE NAME" column

Abbreviation	Explanation
AFB	Air Force Base
ASSC	Association
BADWTR, BW	Badwater
B	Branch
C	California
CO	County, Company
CR	Creek
E	East
ELEM	Elementary
ENG	Engineering
FLT	Flat
HW	Highway
LK	Lake
MERC	Mercury (a town)
M, MI	Mile
MTN, MT	Mountain
N	North, or Nevada
NE	Northeast
No.	Number
NR	Near
NTS	Nevada Test Site
NW	Northwest
OBSERV	Observation
RD	Road
RGE, R	Range
RR	Railroad
S	South
SE	Southeast
SEC	Section
SPR	Spring
ST, STA	Station
SW	Southwest
T	Township
VY	Valley
W	West

identifiers often were assigned using a location estimated from topographic maps, the scale and availability of which varied.

3. **LATITUDE:** North latitude in degrees, minutes, and seconds.
4. **LONGITUDE:** West longitude in degrees, minutes, and seconds.
5. **DATE:** Collection date in year/month/day. In the few cases where a range of sample dates

were given for one analysis, the most recent one was entered. For USGS files, if no date was given, the "date checked" was used. This is usually the date that the results of the analysis were checked in the laboratory by someone other than the analyst.

6. **TIME:** Time of sample collection in hours and minutes, given in 24-hour clock time.
7. **TEMP:** Field temperature of sample in degrees Celsius. If a range was given, the highest temperature was entered.
8. **ALK:** Alkalinity as calcium carbonate (CaCO₃) in milligrams/liter (mg/L).
9. **HARDNESS:** Total hardness as CaCO₃ in mg/L.
10. **COND:** Specific conductance in micro-Siemens/cm at 25 degrees Celsius.
11. **pH:** pH in standard units. All records from NWIS contain laboratory values. Other records may contain either a field or a laboratory value.
- 12–51. Dissolved chemical species concentrations, in units of mg/L: Column headings listed in table 2.
52. **BALANCE:** Cation-anion balance. The following abbreviations were used to differentiate among categories established:
 - B - The analysis balances within ±10 percent.
 - NI - Not enough major ion information is available to calculate a balance.
 - NB - The analysis balance deviates from ideal by more than 10 percent.
53. **DS:** A number defining the source of the data entry. The numbers and corresponding references defining each source are provided in table 3.
54. **LAB:** Abbreviations used to identify the laboratory that performed the analysis. These are listed in table 4.
55. **AQUIFER:** Information on the sampled interval, which may include perforation data, depth sampled, formation name, or aquifer lithology. Abbreviations are defined in table 5.

Table 2. Column headings for dissolved chemical species

Column heading	Dissolved chemical species
Ca	Calcium
Mg	Magnesium
Na	Sodium
K	Potassium
Cl	Chloride
SO ₄	Sulfate
HCO ₃	Bicarbonate
CO ₃	Carbonate
PO ₄	Phosphate
NO ₃	Nitrate
F	Fluoride
SiO ₂	Silica
As	Arsenic
Ba	Barium
Be	Beryllium
B	Boron
Cd	Cadmium
Cr	Chromium
Co	Cobalt
Cu	Copper
Fe	Iron ¹
TOTAL Fe	Total iron
Pb	Lead
Mn	Manganese
Mo	Molybdenum
Ni	Nickel
Ag	Silver
Sr	Strontium
V	Vanadium
Zn	Zinc
Li	Lithium
Se	Selenium
I	Iodide
Br	Bromide
TOTAL N	Total nitrogen
Hg	Mercury
DO	Dissolved oxygen
DOC	Dissolved organic carbon
TDS	Total dissolved solids (residue on evaporation at 180 degrees Celsius)

¹In some cases, the value reported for iron was not clearly defined. Each iron value was entered into the "Fe" column, unless it was indicated to be "total iron," in which case, it was entered into the "TOTAL Fe" column.

- 56. **LITHOLOGY:** Abbreviations for aquifer lithologies or textures, listed in table 6.
- 57. **SAMPLE SOURCE:** Abbreviations identifying the general source type. In cases where no source was indicated, and for which it was deemed likely, it was assumed that the source was a well; otherwise, the column was left blank. Table 7 lists the abbreviations used.
- 58. **COMMENTS:** A collection of general information regarding the sample and/or site, such as sample appearance, well completion information, and additional hydrochemical data. Casing depth, if available and different from total well depth, is listed here. Table 8 lists the abbreviations used.

The following columns were not part of the data base when data were first being entered and therefore are not complete. Some of the data sources may have had information on altitude, well depth, and water level that was not entered as a result of the later inclusion of these columns.

- 59. **ALTITUDE:** Altitude of land surface at well head, with respect to sea level, in feet.
- 60. **WELL DEPTH:** Depth to base of well below land surface, in feet.
- 61. **WATER DEPTH:** Depth to water below land surface, in feet.
- 62. **WL ALT:** Water-level altitude, in feet. The datums used to measure water levels and well depths were variable. In the cases where the datum was not clearly indicated, it was assumed to be land surface. Because the datum most commonly noted was either the altitude of the casing top or land surface, any error resulting from this assumption should be at most a few feet.

Table 3. Data sources and codes

Data source code	Data Sources
1	Benson and McKinley, 1985
2	Benson and others, 1983
3	Blankennagel and Weir, 1973
4	Calzia, 1979a
5	Calzia, 1979b
6	Claassen, 1973
7	Claassen, 1983
8	Claassen, H.C., U.S. Geological Survey, unpublished data
9	Cooperative Extension U.S. Department of Agriculture
10	Craig and Robison, 1984
11	Crowley, 1979a
12	Crowley, 1979b
13	Czarnecki, J., U.S. Geological Survey, unpublished data
14	Dockter and Server, 1979
15	Dockter, 1979
16	Dudley and Larson, 1976
17	Environmental Protection Agency (EPA), unpublished data
18	Glancy, 1968
19	Hardman and Miller, 1934
20	Hunt and others, 1966
21	Lahoud and others, 1984
22	Malmberg and Eakin, 1962
23	Malmberg, 1967
24	Miller, 1977
25	Moore, 1961
26	U.S. Geological Survey, National Water Data Storage and Retrieval System (WATSTORE)
27	Nichols and Davis, 1979
28	Robinson and Beetem, 1975
29	Rush, 1968
30	Schaefer and others, 1992
31	Schoff and Moore, 1964
32	Thomas and others, 1991
33	Thomas, J. (written communication, 1989)
34	U.S. Energy Research and Development Administration
35	U.S. Geological Survey, National Water Information System (NWIS-I)
36	U.S. Geological Survey, unpublished data
37	Waddell, 1984
38	Walker and Eakin, 1963
39	White, 1979
40	Winograd and Thordarson, 1975
41	Winograd, U.S. Geological Survey, unpublished data
42	Whitfield and others, 1985
43	Whitfield, U.S. Geological Survey, unpublished data
44	Young, 1972

Table 4. Abbreviations used to define the laboratory which performed the chemical analysis

Abbreviation	Laboratory
CA DPH	California Department of Public Health
CA DWR	California Department of Water Resources
DHEW	U.S. Department of Health, Education, and Welfare
DRI	Desert Research Institute
EPA	Environmental Protection Agency
LVWD	Las Vegas Water District
NAT PARK	National Park Service
NDH	Nevada Department of Health
NSHL	Nevada State Health Laboratory
NWQL	National Water Quality Laboratory
USBR	U.S. Bureau of Reclamation
USDA	U.S. Department of Agriculture
USGS	U.S. Geological Survey
X	No laboratory information available

Table 5. Abbreviations used in the "AQUIFER" column

Abbreviation	Explanation
DOLO	Dolomite, dolomitic
FM	Formation
GW	Ground water
LMY	Limey
LS	Limestone
LT	Light
PERFS	Perforations
PZC, PC	Paleozoic carbonate rocks
QT	Quaternary
QTAL, QAL	Quaternary alluvium
SLM	Silurian Lone Mountain Dolomite
SPR	Spring
SRM	Silurian Roberts Mountain Formation
SS	Sandstone
Tcb	Tertiary Bullfrog Member of Crater Flat Tuff
Tct	Tertiary Crater Flat Tuff
TD	Total depth
Th	Tertiary tuffaceous beds of Calico Hills
Tos	Tertiary Oak Spring Formation
TV	Tertiary volcanic rocks
W	With
X	No aquifer information available

Table 6. Abbreviations used in the "LITHOLOGY" column

Abbreviation	Explanation
CARB	Carbonate(s)
DOLO	Dolomite
FRAC	Fractured
LS	Limestone
PC, PZ, PZCA, PZC	Paleozoic carbonate rocks
QAL, QTAL	Quaternary alluvium
QTZ	Quartzite
SH	Shale
SS	Sandstone
TAL	Tertiary alluvium
TRAV	Travertine
TV	Tertiary volcanic rocks
WELD	Welded
X	No lithologic information available
ZEO	Zeolitic

Table 7. Abbreviations used in the "SAMPLE SOURCE" column

Abbreviation	Explanation
CT	Cable tool
DR	Drilled
EXPLOR	Exploration
FRAC	Fracture
GW	Ground water
INFILTRA	Infiltration
STA	Station
TUN	Tunnel
X	No sample source indicated

DISCUSSION/DATA LIMITATIONS

Conventions Used

Conventions used in entering the data are as follows:

1. In general, "-99998" indicates that either no data were available or the reported value was indicated to be a "trace amount." In the case of the "incomplete" columns (ALTITUDE, WELL

DEPTH, WL ALT, and WATER DEPTH), it also can mean that no data were entered.

2. A negative chemical concentration value indicates that the concentration is "less than" the absolute value of the number listed.

Table 8. Abbreviations used in the "COMMENTS" column

Abbreviation	Explanation
ALLUV	Alluvium
BI	Bismuth
BLK	Black
BOUND	Boundary
BRN	Brown
BX	Borax
CARB	Carbonate
CO	County
COLLUV	Colluvium
COOR	Coordinates
CSE TD	Casing run to total depth
COMMUN	Communication
DK	Dark
DSTRBUTARY	Distributary
DIV	Division
DOLO	Dolomite
E	East
FM	Formation
FR	From
FRAC	Fractured
GA	Gallium
GE	Germanium
GRN	Green
LAT/LONG	Latitude and longitude
LI	Lithium
LT	Light
LS	Limestone
LOC	Location
M	Meters
MEAS	Measured
MI	Miles
MIN	Minutes
ML	Milliliters
MTN	Mountain
N	North
NEV	Nevada
NR	Near
NTS	Nevada Test Site

Table 8. Abbreviations used in the "COMMENTS" column
--Continued

Abbreviation	Explanation
OH	Hydroxide
PC, PZC	Paleozoic carbonate rocks
PERF	Perforations, perforated
PHREATO	Phreatophytes
PICKLEWD	Pickleweed
PPM	Parts per million
PROB	Probably
QAL, QTAL	Quaternary alluvium
QUAD	Quadrangle
QUANT, Q	Quantitative
PROD	Production
RB	Rubidium
S	South
SALTGR	Saltgrass
SE	Selenium
SE	Sediment
SLI	Slightly
SPR	Spring
SN	Tin
ST	State
STA	Station
SR	Strontium
T	Temperature
TABL, TBL	Table
TD	Total depth
VEG	Vegetation
W	With
WL	Water level
WH	Well head
WTR	Water
X	No comments

Location Accuracy

When not given in the respective sources, the latitude and longitude of each site were determined and are included in the data base. For many sites, the sources provided locations only in terms of township and range or Nevada State plane coordinates. These were converted to latitude and longitude before entry into the data base. The Nevada State plane coordinates were converted using projection definitions provided by the geographic information system ARC/INFO. Township and range locations were converted to latitudes and longitudes by direct measurements from topographic maps at scale 1:100,000, utilizing either a

variable scale or a digitizer. If the data source had a discrepancy between the township and range location and the latitude and longitude, the latitude and longitude were assumed to be correct. Locations of sites for which only the name of the well or spring were given were determined as accurately as possible using any available sources, such as reports or maps. In some cases, the information was not clear and judgment had to be used to assign a location. In general, sample locations are accurate to within 1 kilometer. Most are much more precisely located than that; a few, however, may be less accurate.

Methods Used in Computing Cation-Anion Balances

Conventions and assumptions used in balancing the analyses are as follows:

1. All "less than" values were assumed to be equal to zero.
2. In most cases, the major cations (calcium, magnesium, sodium, and potassium) and the major anions (bicarbonate, carbonate, sulfate, and chloride) were used to balance the analyses.
3. When bicarbonate and carbonate data were not given, alkalinity, if available, was used to estimate a bicarbonate concentration. In the cases where cation data were inadequate to calculate a balance, an attempt was made to use hardness to estimate the sum of calcium and magnesium concentrations. Only a few analyses were balanced using these estimating procedures.
4. A few analyses were balanced by including fluoride data. For others, some ion pairs such as sodium and potassium or bicarbonate and carbonate were summed together in the data source and therefore could not be separately entered into the data base. The combined data, however, were used to balance the analyses by assuming that the reported concentrations represented those of the major ion of the pair.
5. Analyses that did not balance initially were checked for errors and inconsistencies in the data. Several records were balanced after such problems were corrected.

Editing Procedure

The original data compilation, UNEDIT, contains 4,738 analyses, some of which are duplicates or near duplicates. Near duplicates are records which are not completely identical because they were obtained from different sources. In the edited file, DATAEDIT, actual duplicate records were removed. In addition, many discrepancies in near duplicates were resolved and the records were combined. The individual sources of combined records are noted in the data-source column. Identifiable errors in the data were corrected during editing.

The minor discrepancies in near-duplicate records were due to different reporting formats in the original sources and were of three types. The first type occurred when one or more of the records contained data that were not in the others. In these cases, the data were combined into one record. The second type was a discrepancy in one or more parameter values. In these cases, an attempt was made to determine which record was correct. If a copy of the original laboratory report could be located, it was used to select the correct value and the other value was removed from the data base. If the discrepancy could not be resolved, both records were left in the data base. The third type of discrepancy was due to different conventions used in reporting the data. Discrepancies of this type were most common in the minor element data. For example, three near-duplicate records may show manganese values of <0.01, 0.01, and 0.0. Again, if a copy of the original laboratory report was available, it was used to select the correct value and the other value was removed from the data base. If the discrepancy could not be resolved, two records were left in the data base, one containing <.01 and one containing 0.0. Another example would be the case of five records, three showing a value of 0.2 for a certain element and two showing 0.5. In this case, if the discrepancy could not be resolved, two records would be left in the data base, one showing 0.2 and one showing 0.5. In general, there were more discrepancies for iron than for any other minor element. This was probably due to the different ways in which iron concentrations were expressed and because the convention used often was not clearly stated. Some other conventions were used when combining near-duplicate records showing discrepancies in either alkalinity or pH. For discrepancies in alkalinity, the highest value was chosen; for pH, the lowest value was chosen.

The final step in editing was to resolve location discrepancies among multiple records for a single well or spring so that all were assigned the same location in terms of latitude and longitude. In general, the NWIS

locations were considered to be most accurate and were given precedence. Next were the locations as shown in USGS Open-File Report 90-355 (McKinley and others, 1991). Locations given in other USGS reports were used for sampling locations not contained in either of the first two sources.

Data-Base Limitations

Based on the completeness of individual analyses and on their calculated cation-anion balances, the analytical data contained in the data base are of variable utility. Of the 3,733 analyses in the edited data base, 58 percent (2,178) balanced to within ± 10 percent. Of the remaining records, 1,373 did not contain enough major ion data to calculate a balance.

The data base has some deficiencies. No distinction was made between field and laboratory pH. Field and laboratory inorganic carbon values (bicarbonate, carbonate, alkalinity) also were not differentiated. In addition, stable and radioisotopic data were omitted. These data, which are available for some sites, include deuterium ($\delta^2\text{H}$), tritium (^3H), oxygen ($\delta^{18}\text{O}$), carbon ($\delta^{13}\text{C}$ and ^{14}C), strontium ($\delta^{87}\text{Sr}$ and ^{90}Sr), and a few other radionuclides. The majority of the isotopic data available comprise $\delta^2\text{H}$, ^3H , and $\delta^{18}\text{O}$ values.

More than one abbreviation convention was sometimes used in the data-base columns. This is a result of using multiple sources and the way in which the data base was developed.

SUMMARY

Ground-water chemistry data have been compiled for the Yucca Mountain, Nevada, regional area. Primary sources for the data were USGS files, USGS National Water Information Systems (NWIS), and published reports. The data are contained in two compressed files which self-expand into Lotus (.WK1) files, an unedited version, UNEDIT, containing 4,738 records and an edited version, DATAEDIT, containing 3,733 records. Editing included the removal of duplicate records and the combining of records, when appropriate. In addition, some errors were removed and some records made more consistent.

The analyses presented are of variable quality and comprehensiveness and include no isotopic data. Of the 3,733 analyses in the edited data base, 58 percent (2,178) can be balanced to within ± 10 percent, 37 percent are not sufficiently complete for a balance to be calculated.

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