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DATA ON SNOW CHEMISTRY
OF THE CASCADE-SIERRA NEVADA MOUNTAINS

By L. B. Laird, H. E. Taylor, and R. E. Lombard

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Multiply	by	to obtain
millimeter (mm)	0.03937	inch (in.)
centimeter (cm)	0.3937	inch (in.)
meter (m)	3.281	foot (ft)
liter (L)	2.113	ounce, fluid (oz)
	1.057	pint (pt)
	0.2642	gallon (gal)

Temperature Conversion

degree Celsius $^{\circ}F = 9/5\ ^{\circ}C + 32$ degree Fahrenheit

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INTRODUCTION

The analysis of snow chemistry data given in this report is presented in the report "Snow Chemistry of the Cascade-Sierra Nevada Mountains" by L. B. Laird, H. E. Taylor, and V. C. Kennedy (Environmental Science and Technology, 1986, in press).

This investigation was designed to assess geographic variations and trends in atmospheric deposition in Washington, Oregon, and California by sampling the snowpack in the Cascade-Sierra Nevada Mountains from the U.S.-Canadian border to a point northeast of Bakersfield, California. The study was prompted by a concern about the potential for acidification of sensitive lakes and streams in the Cascade-Sierra Nevada Mountains and associated impacts on the forests of this region, as well as the overlying need to further identify the depositional pattern of constituents from natural and anthropogenic sources. The study was designed not to identify specific sources of airborne materials, but to provide a very general assessment of deposition and provide the basis for further research. Snow sampling was selected for several reasons: the snowpack provides an integration of precipitation events under what are probably varying conditions of natural and anthropogenic water-soluble and particulate-chemical outputs; the snowpack is an accumulator of dry fallout during non-storm periods; the snow accumulates during the wet winter season and contains much less windblown dust and other terrestrial material than at other times of the year (Powers and others, 1981); and a large geographic area could be sampled more readily by this approach.

This report presents data only for the solutes that were found in the snow. The insoluble particulate matter in each sample was carefully separated and will be the subject of future examinations. The constituents and properties presented in this report are pH, hydrogen ion, calcium (Ca), magnesium (Mg), sodium (Na), potassium (K), chloride (Cl), sulfate (SO_4), nitrate (NO_3), fluoride (F), phosphate (PO_4), ammonium (NH_4), iron (Fe), aluminum (Al), manganese (Mn), copper (Cu), cadmium (Cd), lead (Pb), and dissolved organic carbon (DOC). Analyses were also made for arsenic (State of Washington samples) and bromide, but concentrations were below the detection limit (table 1).

SNOW SAMPLING

Sampling of the mountain snowpack near maximum accumulation, but before spring melt started, was deemed to be the simplest and most effective method of assessing depositional patterns of airborne chemicals in this region. However, use of snow data has some shortcomings. The Cascade and Sierra Nevada Mountains have a "warm" snowpack with temperatures usually close to $0^{\circ}C$ (Smith, 1972). Because of air-temperature variations, some melting of the snowpack often occurs during the winter, and, depending on temperature conditions, rain may fall on the snowpack and also provide some downward percolation. Such percolation, if it continues through the entire depth of the snowpack, can leach soluble material from the snow, disproportionate to the concentrations in the snowpack (Colbeck, 1981; Johannessen and others, 1980). In addition, Colbeck (1981) found that the rate at which impurities are removed from the snow depends upon the atmospheric conditions under which the snow was deposited, as well as the degree and type of metamorphism the snow has experienced and the intensity of rain and (or) melt events. Thus, the snowpack cannot be assumed to accumulate and hold all atmospheric deposition during the life of the snowpack, nor can it be assumed to lose chemicals due to surface melting or rain on the snow. However, to lessen the possibility of rain and melting impacts, almost all sampling locations (66 of 70) were located above 1,680 meters in elevation and sampling occurred in late winter before the spring melt of the snow began. Wherever possible, the sampling points were located in the southwestern part of meadows or open areas to lessen surface melting from solar radiation. In addition, to assess the loss of chemicals from the snowpack, four 2-m x 2-m waterproof boxes were set out in November prior to major snowfall and snow cores were collected from the snow column inside and outside of the boxes during the late winter sampling period. The snow chemistry of the respective cores showed little variation between cores in each set (see later discussion). For these reasons, the snow core data collected in the main north-south traverse are believed to allow reasonable comparisons of variations and geographic trends in soluble substances in the atmospheric deposition.

Complete snow cores from snow surface to ground surface were taken from late February to mid-March 1983. The cores were collected at approximately 25-km intervals, just west of the general crest of the mountain ranges, from the U.S.-Canadian border to a point in south-central California (fig. 1). Sampling was done at the highest elevation practicable in the individual areas. Sampling elevations ranged from 1,280 to 3,140 m, and the median was 2,040 m. Statistical data for the snow sample analyses are given in table 2.

The snow cores were collected with a stainless steel sampler of Federal Snow Sampler design (cutter head opening 3.77 cm). No extrusion from the core barrel was necessary; the snow sample
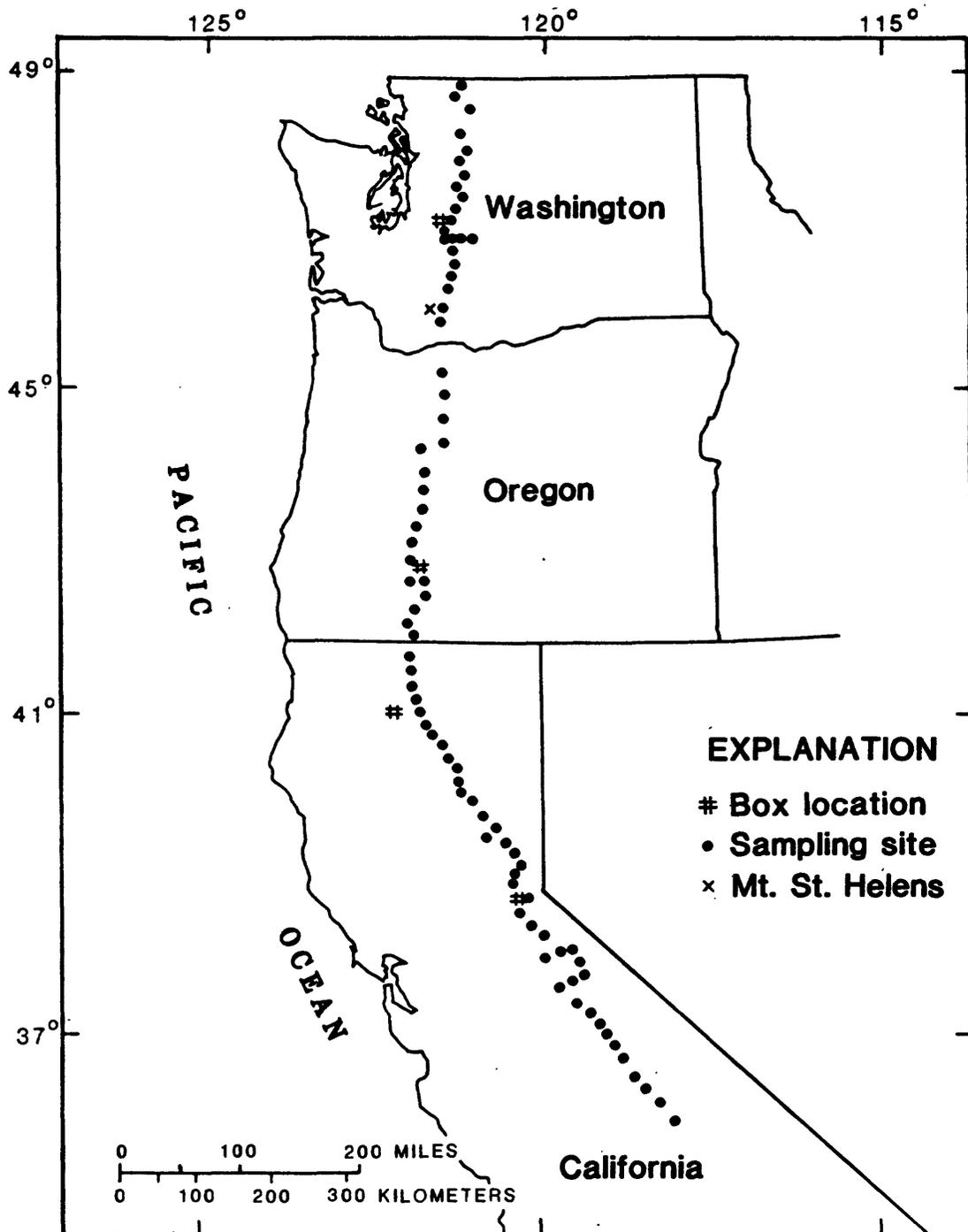
FIGURE 1. Snow sample sites.

could usually be easily dislodged from the sampler. The lower 7-8 cm of the sample was routinely discarded to eliminate contamination from the underlying soil or rock. Several complete cores, taken to a polyethylene-covered plywood surface at ground level, included the lower 7-8 cm of snow and were analyzed for the chemical constituents and properties listed above. These were compared to adjacent cores from which several centimeters of snow at the bottom were discarded. There were no significant differences. The stainless steel snow sampling tubes were triple-rinsed with distilled deionized water after each sampling and handled with disposable plastic gloves. All samples were immediately double-bagged in polypropylene plastic, heat sealed, and maintained in a frozen state by mechanical refrigeration from the point of collection until analyzed in the USGS laboratories in Denver, Colorado. Helicopter transport was utilized between all sample sites and care was taken to assure that the jet engine exhaust from the helicopter did not contaminate the sampling sites.

Duplicate Samples

Duplicate samples were collected at 16 of 70 snow sampling locations. These samples are noted with a "D" in the data tables. The snow core for the duplicate samples was collected about a meter from the core for the primary sample, immediately following the original sampling. Table 3 lists the precisions of duplicate samples at typical concentration levels of each of the solutes using the technique of Koch and Link (1971). The application of this technique to these snow sample data is outlined in Laird and others (1986, in press).

East-West Sampling Transects

A limited sampling was made to determine any prominent east-west depositional trends and (or) changes because of elevation of the sampling sites. In six areas, one to three additional samples were collected in an east-west transect (fig. 1) roughly perpendicular to the main north-south sampling line and in conjunction with a regular sample in the north-south line. These east-west sampling points were usually at lower elevations than the main line samples, but always above 1,680 m. These samples are noted with a "T" after the sample number in the data tables.

Sample Integrity

Loss of solutes from the snowpack was a concern in the design of this sampling program. As Smith (1974) reports, the Cascade-Sierra Nevada Mountains have warm snowpacks--those whose interior temperature below 30 cm stay at or near 0°C all or most of the snow season. Numerous investigations (Welch and others, 1983; Colbeck, 1981; Johannessen and others, 1980; Skartveit and others, 1979) have reported on the process of the loss of solutes from a snowpack during the winter, but particularly during the spring-melt period.

To assess the loss of solutes from the snowpack during the winter, four wooden containers about 2 m square, lined with plastic, were placed at locations above an elevation of 1,700 m, near the north-south sampling route, in early winter (fig. 1). Immediately following the collection of the main body of samples, the boxes were visited and snow cores collected from the snowpack over the box and outside of the box. The boxes were then dug out and the condition of the snow in and outside of the box examined. In each case, the 15 constituents and properties analyzed compared very closely for each pair of samples except for calcium and sulfate, but these latter results were inconsistent (table 4). Calcium was greater inside the box at three sites, less at one, and sulfate was greater inside the box at two and less at two. The snow was dry with no sign of melting in or outside of three of the boxes, while one box (Mount Shasta) contained about 5 cm of slush. The slush in the box may have been produced by melting of the snowpack and (or) rain on the snowpack or may have been due to precipitation at the time the box was emplaced. Heavy precipitation that was a mixture of snow and rain fell throughout the day the site was established, and the temperature was close to 0°C. Outside of the Mount Shasta box, the snow at the soil was fine grained and showed no appearance of metamorphic change, suggesting that the snow near the ground may not have been subject to melting or percolation of water through the snowpack.

LABORATORY PROCREDURES

The very low solute concentrations of the snow required special handling techniques in the laboratory as well as in the field. In addition, established analytical methods were modified as necessary to improve sensitivity to the very low concentrations. The sample preparation and laboratory methods are described below.

Sample Preparation

To insure uniform handling of all samples, the melting, filtration, and bottling process followed a strict protocol. The double-bagged samples were allowed to thaw under two infrared heat lamps. After approximately 90 percent of the snow had melted (7-8 hours), the samples were placed inside a large walk-in refrigerator with a temperature regulated at $4^{o}C$ and left overnight to complete the thawing. By this procedure, the overall temperature of the sample never exceeded $4^{o}C$, and hence any bacterial deterioration of the nutrient constituents was minimized as well as adsorption of trace metals on the surfaces of the polypropylene bag.

Immediately after thawing, the samples were filtered, preserved, and bottled. After agitating the bag to suspend any settled material, pressure filtration was performed in two steps using a peristaltic pump and silicone tubing. In the first step, approximately 100 mL of the sample was passed through a 0.45-micrometer-pore-diameter, 47-millimeter-diameter silver membrane filter housed in a stainless steel in-line holder. The sample was collected in a glass screw-cap bottle and reserved for dissolved organic carbon analysis.

In the second step, up to 2 liters of sample (depending on the total volume of the melted snow core) was filtered through a 90-mm, 0.4-micrometer-pore-diameter polyethylene membrane filter. The filtration assembly, as described by Shockey and Taylor (1984), consisted of an apparatus to permit the differential pumping of the sample through the membrane filter. Approximately 20 mL of sample was used to rinse the pump tubing and the filter apparatus. After rinsing, 1 liter of the filtered sample was collected in a polyethylene bottle (previously rinsed with nitric acid) and reserved for metals analysis. The sample was preserved by the addition of 1 mL of double-distilled, high-purity con-centrated nitric acid for each liter of sample. Up to an additional 1 liter of filtrate was collected in a deionized water-rinsed polyethylene bottle and saved for nutrient determinations. Finally, a 20-mL portion of filtrate was transferred to a plastic beaker for the immediate determination of pH and specific conductance.

As each 1-liter bottle of nutrient sample was collected, it was immediately preserved by a quick-freezing technique. The sample bottle was rapidly immersed in a dewar of liquid nitrogen. This quickly formed a thin layer of ice on all internal surfaces of the bottle. By the principle of zone reference, ions were preferentially excluded from this ice shell, thereby creating a barrier to the diffusion of anions to the active sites on the container walls. After this ice-layer forming process, the bottles were transferred to a conventional deep freezer where the samples were completely frozen and were stored until all samples had been filtered and were ready for analysis.

Analytical Methods

A variety of methods was used for the analysis of specific constituents in the samples obtained from the preparation of the melted snow cores. The techniques and procedures are summarized by groups of constituents determined by a specific analytical technique. In all cases, stock solutions of calibration standards were prepared from ultra-high-purity metals or metal salts dissolved in distilled deionized water and stored in ultra-high-purity, nitric-acid-rinsed (for metals) Teflon bottles.

Techniques for the simultaneous determination of selected trace metals in natural water samples by inductively coupled plasma emission spectrometry have been reported by Garbarino and Taylor (1979). Determinations were made by direct nebulization, using a crossflow pneumatic nebulizer of filtered and acidified (nitric acid) samples into a 27.1-megahertz argon plasma operating at 1.25 kilowatt. Table 1 lists the elements which were determined by this technique and the detection limits which were obtained under these operating conditions. In each case these specific spectral lines were chosen to minimize spectral interferences normally encountered in natural water matrices while optimizing the intensity of the spectral line to provide maximum sensitivity for the analysis.

Potassium analyses were performed by conventional atomic absorption spectrometry utilizing an air-acetylene flame atomization device as reported by Skougstad and others (1979, p. 229). Absorption measurements were made using the 766.5-nanometer resonance spectral line using a slightly reducing flame. By this procedure, a detection limit of 10 micrograms per liter was obtained.

The trace metals aluminum, cadmium, copper, and lead were found to be present at concentration levels (sub-microgram/liter) substantially below those which could be determined by conventional flame atomic absorption or inductively coupled plasma emission spectrometry. Therefore, samples were analyzed for these elements by electrothermal-atomization (graphite furnate)

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atomic absorption spectrometry. The procedure was similar to that reported by Shrader and others (1983).

For cadmium, copper, and lead, improved sensitivity and precision were obtained by five successive 50-microliter aliquots of sample dispensed into the graphite furnace tube, with solvent evaporation at 110°C occurring between each aliquot deposition. This procedure resulted in the analyte residue being concentrated reproducibly in the center of the graphite tube at the time of atomization rather than being dispersed over the entire bottom of the tube as would have been the case if a single 250-microliter aliquot was used. Aluminum was determined by dispersing 10 successive 15-microliter aliquates onto a graphite platform mounted in the graphite tube, evaporating solvent between each aliquot. Use of the graphite platform has been described by Kaiser and others (1981).

Ammonium, nitrate, and phosphate ions were determined spectrophotometrically by specially optimized, low-concentration-level absorption spectrophotometry. All analyses were performed on unpreserved samples that were maintained frozen until just prior to analysis, to avoid contamination from the use of antibacterial preservatives and to inhibit adsorption on the wall surfaces of the sample containers.

The ammonium-ion determination has been described by Skougstad and others (1979, p. 389), and consists of reacting the sample solution with sodium salycilate, sodium nitroprusside, and sodium hypochlorite in an alkaline medium and measuring the absorbance of the developed color in a 15-mm cell at 660 nanometers. By this procedure, a detection limit of 3 micrograms per liter, as nitrogen, was achieved.

The determination of nitrate ion, as described by Skougstad and others (1979, p.437), involved the chemical reduction of all nitrate ions to nitrite ions by passing the sample through a granular copper-cadmium alloy-packed column. After reduction, the nitrite was reacted with sulfanilamide dihydrochloride to form a colored species whose absorbance was measured in a 15-mm cell at 520 nanometers. A detection limit of 2 micrograms per liter, as nitrogen, was obtained by this procedure.

Phosphate was determined by converting all phosphorus to ortho-phosphate by an acid persulfate digestion followed by reaction with ammonium molybdate which, after reduction with ascorbic acid, formed a colored species as described by Skougstad and others (1979, p.453). Its absorbance of this species was measured in a 15-mm cell at 660 nanometers, which produced a detection limit of 2 micrograms per liter as phosphorus.

Dissolved organic carbon was determined by an infrared absorption spectrometric technique (Wershaw and others, 1983). After acidification of the sample, all inorganic carbon (carbonate and bicarbonate) was decomposed to carbon dioxide and

removed by purging the sample with an inert gas. All dissolved organic carbon was oxidized with potassium persulfate at 120°C in a closed container and the resulting carbon dioxide oxidation product was measured with a carbon analyzer. This procedure permitted the collective determination of all dissolved organic carbon species to a detection limit of 0.1 milligram per liter.

Chloride, fluoride, and sulfate ions were determined by ion exchange chromatography. Techniques described by Hedley and Fishman (1982) were modified to obtain maximum sensitivity and lowest detection limits. Detection limits of 10 micrograms per liter were achieved for all three anions.

Specific conductance was measured using a direct-reading conductance bridge equipped with a dip-type cell with a cell constant of 0.326. Specific conductance was measured at the time of sample preparation, immediately after the sample filtration step.

An Orion Model 601A Ionanalyzer with a custom-designed, low-ionic-strength glass electrode was used to measure pH potentiometrically. The pH meter was calibrated using special low-ionic-strength solutions prepared by diluting a sulfuric acid stock solution sufficiently to obtain theoretical pH values of 1.97, 3.65, 6.66, and 7.52. These solutions were used to calibrate the pH meter periodically and to serve as quality control samples to insure satisfactory performance. All pH determinations were made at the same time as the specific conductance measurements.

Quality Assurance

Because of the extremely low concentrations of soluble materials in the snow, great care was exercised in sampling, handling, and analysis.

Blanks were carried through all steps of the preparation and analysis, and appropriate corrections were made to the data to accommodate any blank values found. In substantially all cases, blanks were measured at levels below the detection capability of the analytical technique employed. Great efforts were made to identify and eliminate all sources of blank contamination during pilot studies which were performed before actual sample handling and analysis was initiated.

To minimize the possibility of systematic errors arising from day-to-day variations in instrumentation, standardization, and any other non-random sources, samples were retained until all preparation was completed. Analyses were then performed as near to simultaneously as possible for a given parameter. For all parameters, samples were analyzed in a random order, with reference standards and blanks interspersed at a 10-percent frequency. In addition, duplicate samples, chosen at random and comprising 25 percent of the total sample set, were randomly interspersed with the other samples during the analysis campaign. Field duplicates were also randomly collected at 20 percent of the sampling sites to establish the relative precision of field procedures and techniques.

The standard reference materials consisted of U.S. Geological Survey Standard Reference Water Samples (SRWS) Nos. 69, 73, 74, 75, 80, and N7 and National Bureau of Standards SRM 1643a. In order to approximate the concentration levels anticipated in the snow melt samples, SRWS Nos. 69 and 75 were diluted 1/100 and SRWS Nos. 74 (for chloride and sulfate only), 80, and N7 were diluted 1/10. Table 5 lists each of the parameters along with the mean values of the analysis of the standard reference material and the confidence interval at the 95-percent confidence level of the determinations. Also listed is the round-robin distributions (Fishman, M. J., written communications, 1979, 1980, and 1982; Janzer, V. J., written communication, 1983) of the USGS Standards.

As can be seen from table 6, a comparison of the mean concentration values and the standard errors of the means shows that all parameters were determined well within the experimental error of the analytical procedures.

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TABLES 1 THROUGH 7

Table 1.--Methods of analysis, detection limit of chemical constituents, and properties of snow samples

Parameter	Method of analysis	Detection limit, in mg/L
specific conductance	conductance bridge/dip cell	--
pH	potentiometric/glass electrode	--
Ca	ICP atomic emission spectrometry	0.002
Mg	ICP atomic emission spectrometry	.003
Na	ICP atomic emission spectrometry	.01
K	atomic absorption spectrometry	.01
SO_4	ion exchange chromatography	.01
Cl	ion exchange chromatography	.01
Br	fluorescence spectrometry	.005
F	ion exchange chromatography	.01
N as NO_3	absorption spectrometry	.002
N as NH_4	absorption spectrometry	.003
P as PO_4	absorption spectrometry	.002
Al	graphite furnace atomic absorption spectrometry	2×10^{-5}
As	atomic absorption spectrometry	.001
Cd	graphite furnace atomic absorption spectrometry	2×10^{-6}
Cu	graphite furnace atomic absorption spectrometry	5×10^{-6}
Fe	ICP atomic emission spectrometry	1×10^{-4}
Pb	graphite furnace atomic absorption spectrometry	2×10^{-4}
Mn	ICP atomic emission spectrometry	1×10^{-4}
DOC	infrared adsorption spectrometry	0.1

Table 2.--Statistical data on snow samples

Constituent	Maximum	Minimum	Mean	Median
specific conductance[a]	6.10	1.78	2.8	2.52
pH	5.88	5.11	--	5.58
H+ (milliequivalent)	0.008	0.0005	0.003	0.003
Ca[b]	0.16	0.005	0.042	0.36
Mg[b]	0.051	0.003	0.009	0.003
Na[b]	0.26	0.01	0.07	0.06
K[b]	0.30	0.01	0.019	0.01
SO_4[b]	0.32	0.04	0.14	0.13
Cl[b]	1.0	0.01	0.22	0.16
F[b]	0.10	0.01	0.03	0.03
N as NO_3[b]	0.12	0.002	0.025	0.022
N as NH_4[b]	0.18	0.003	0.08	0.010
P as PO_4[b]	0.022	0.002	0.005	0.004
Al[b]	100.	0.18	3.2	1.7
Cd[c]	0.96	0.024	0.12	0.073
Cu[c]	3.8	0.100	0.44	0.28
Fe[c]	8.5	0.1	0.92	0.1
Pb[c]	1.1	0.05	0.33	0.28
Mn[c]	7.8	0.01	1.0	0.7
DOC[b]	4.1	0.20	0.60	0.50

[a] in microsiemens per centimeter squared
[b] in milligrams per liter
[c] in micrograms per liter

Table 3.--Confidence intervals of duplicate samples based on overall
            precision

Parameter	Units	Concentration[a]	Precision
specific conductance	uS/cm	2.65	± 0.22
pH	units	5.52	± 0.11
calcium	mg/L	0.031	± 0.02
magnesium	"	0.018	± 0.01
sodium	"	0.049	± 0.01
potassium	"	0.018	± 0.01
sulfate	"	0.14	± 0.03
chloride	"	0.33	± 0.09
fluoride	"	0.037	± 0.01
nitrate	"	0.065	± 0.004
ammonium	"	0.003	± 0.01
phosphate	"	0.025	± 0.002
cadmium	ug/L	0.103	± 0.02
copper	"	0.50	± 0.2
iron	"	1.2	± 0.2
lead	"	0.291	± 0.08
manganese	"	1.4	± 0.5

[a]Average parameter concentration of duplicate snow cores.

Table 4.--Calcium and sulfate concentrations for box sites

Location/Elevation	Concentration, in milligrams per liter	
	Calcium	Sulfate
Mount Rainier, 1707 meters		
inside box	0.024	0.22
outside box	0.011	0.12
Crater Lake, 1966 meters		
inside box	0.013	0.07
outside box	0.020	0.10
Mount Shasta, 1768 meters		
inside box	0.022	0.31
outside box	0.013	0.49
Donner Pass, 2134 meters		
inside box	0.022	0.25
outside box	0.013	0.10

Table 5.--Precision of analytical determinations made on snow samples
(95 percent confidence interval)

Parameter	Units	Concentration[a]	Precision
spec. cond.	uS/cm	2.90	± 0.08
pH		5.56	± 0.01
calcium	mg/L	0.115	± 0.02
magnesium	"	0.081	+ 0.03
sodium	"	0.293	± 0.01
potassium	"	0.124	± 0.02
sulfate	"	0.017	± 0.02
chloride	"	0.258	± 0.05
nitrate	"	0.0257	± 0.002
ammonium	"	0.0415	± 0.008
cadmium	ug/L	0.807	± 0.004
copper	"	0.95	± 0.2
iron	"	2.68	± 0.02
lead	"	0.400	± 0.02
manganese	"	1.47	± 0.05

[a]Average concentration of split sample subset.

Table 6.--Summary of Standard Reference Material accuracy and precision

Parameter	Units	SRM[a]	SRM mean	SE[b]	experimental Mean	experimental SE
calcium	mg/L	74	7.48	0.15	7.46	0.01
magnesium	"	"	1.94	0.04	1.94	0.01
sodium	"	"	2.77	0.08	2.81	0.01
potassium	"	80	0.437	0.008	0.426	0.003
sulfate	"	"	1.43	0.07	1.43	0.01
chloride	"	74	0.140	0.03	0.141	0.007
nitrate (N)	"	"	2.43	0.11	2.48	0.0
phosphate (P)	"	N 7	0.029	0.002	0.030	0.002
aluminum	ug/L	69	3.10	0.32	3.37	0.08
cadmium	"	75	0.079	0.004	0.084	0.006
copper	"	73	0.626	0.023	0.613	0.049
iron	"	1643a	88	4	85	2
lead	"	69	0.023	0.006	0.027	0.009
manganese	"	1643a	31	2	31	1

[a]SRM = standard reference material.

[b]SE = standard error at 0.95 confidence level (Cu, Cd, Pb, K, Al; SE obtained by dividing SE by dilution factor)

Table 7.--Cascade-Sierra Nevada snow chemistry data

[D, duplicate sample; S, sample of surface snow; A, added sample point; T, east-west transect sample;
Specific conductance is reported in micromhos per centimeter at 25 Celsius; pH is reported in pH units;
hydrogen ion is reported as microequivalents per liter; all other constituents are reported as dissolved
in milligrams per liter.]

Sample No.	Location		Latitude	Longitude	1983 Date sampled	Altitude (m)	Snow depth (cm)	Content (cm)	Specific conductance µS/cm	pH	Hydrogen ion (H+) µeq.	Calcium (Ca) mg/L
01	Mt. Redoubt,	WA	48 57'26"	121 19'40"	Feb 21	1905	262	79	2.84	5.34	4.57	.014
01D	Mt. Redoubt	WA	48 57'26"	121 19'40"	Feb 21	1905	262	86	2.76	5.48	3.31	.016
01S	Mt. Redoubt	WA	48 57'26"	121 19'40"	Feb 21	1905	20	--	4.76	5.29	5.13	.035
02	Mt. Blum	WA	48 46'22"	121 27'58"	Feb 21	1829	406	142	3.18	5.37	4.27	.005
03	Hidden Lake	WA	48 29'38"	121 11'37"	Feb 21	1981	399	94	5.35	5.11	7.76	.037
04	Green Mountain	WA	48 17'26"	121 15'01"	Feb 21	1859	274	91	3.16	5.40	3.98	.028
05	Sloan Peak	WA	48 01'15"	121 19'54"	Feb 23	1987	467	--	3.28	5.60	2.51	.062
06	Bench Mark Mtn.	WA	47 55'22"	121 12'05"	Feb 22	1737	381	119	2.95	5.43	3.72	.031
07	Gunn Peak	WA	47 49'08"	121 27'30"	Feb 23	1829	312	130	3.45	5.42	3.80	.054
08	McLain Peaks	WA	47 41'30"	121 33'54"	Feb 23	1433	254	102	3.23	5.70	2.00	.021
09	Preacher Mountain	WA	47 30'15"	121 31'05"	Feb 23	1774	414	155	4.15	5.49	3.24	.066
10	Jolly Mountain	WA	47 24'39"	121 00'04"	Mar 22	1707	335	112	2.38	5.40	3.98	.009
11	Kelly Butte	WA	47 10'20"	121 28'57"	Mar 22	1646	183	86	2.60	5.40	3.98	.014
12	Tolmie Peak	WA	46 57'21"	121 53'06"	Feb 25	1756	259	84	4.38	5.40	3.98	.039
13	Mount Rainier N.P.	WA	46 49'28"	121 52'00"	Feb 25	1829	335	142	3.27	5.51	3.09	.040
13AT	Mount Rainier N.P.	WA	46 50'29"	121 52'25"	Apr 15	1701	335	--	3.22	5.47	3.39	.028
13ADT	Mount Rainier N.P.	WA	46 50'29"	121 52'25"	Apr 15	1701	335	140	3.34	5.44	3.63	.040
14T	Mount Rainier N.P.	WA	46 52'44"	121 48'54"	Apr 15	2182	361	--	2.48	5.52	3.02	.044
15AT	Mount Rainier N.P.	WA	46 50'19"	121 39'13"	Apr 15	2262	272	--	3.27	5.29	5.13	.031
16	Tatoosh Lakes	WA	46 42'57"	121 41'13"	Feb 25	1707	422	140	3.63	5.52	3.02	.063
17	South Point	WA	46 31'14'	121 38'31"	Feb 25	1558	274	94	3.36	5.63	2.34	.13
17D	South Point	WA	46 31'14"	121 38'31"	Feb 25	1558	267	79	3.38	5.54	2.88	.066
18	Langilli Cr. Peak	WA	46 21'10"	121 49'27"	Feb 26	1655	211	71	4.22	5.88	1.32	.066
19	Mount Adams	WA	46 10'09"	121 30'24"	Feb 27	2076	315	102	2.47	5.65	2.24	.12
19S	Mount Adams	WA	46 10'09"	121 30'24"	Feb 27	2076	20	--	2.59	5.45	3.55	.017
20	Bird Mountain	WA	46 02'45"	121 46'09"	Feb 28	1722	533	178	3.30	5.73	1.86	.047
21	Big Huckleberry Mt.	WA	45 51'04"	121 46'42"	Feb 28	1280	208	117	6.10	5.18	6.61	.061
23	Mount Hood	OR	45 19'42"	121 40'23"	Feb 28	1750	439	175	2.97	5.70	2.00	.028
23D	Mount Hood	OR	45 19'42"	121 40'23"	Feb 28	1750	447	170	3.52	5.48	3.31	.017
24	Mount Wilson	OR	45 04'03"	121 38'54"	Mar 1	1707	152	51	3.17	5.48	3.31	.035
25	Olallie Butte	OR	44 49'06"	121 45'06"	Mar 2	2073	224	72	4.48	5.62	2.40	.024
27	Mount Jefferson	OR	44 38'50"	121 47'13"	Mar 2	2109	381	168	2.52	5.70	2.00	.038
28	Bachelor Mountain	OR	44 37'43"	122 00'43"	Mar 2	1743	343	145	2.72	5.69	2.04	.058
29	Echo Mountain	OR	44 24'36"	122 05'56"	Mar 2	1743	274	97	2.72	5.65	2.24	.045
30	Horsepasture Mtn.	OR	44 07'06"	122 04'37"	Mar 2	1707	196	65	2.53	5.61	2.45	.028
31	Chucksney Mtn.	OR	43 55'42"	122 06'33"	Mar 2	1756	208	69	2.38	5.53	2.95	.044

Magne-sium (Mg) mg/L	So-dium (Na) mg/L	Po tas-sium (K) mg/L	Sul-fate (SO4) mg/L	Chlo-ride (Cl) mg/L	Fluo-ride (F) mg/L	Nitro-gen as NO3 mg/L	Nitro-gen as NH4 mg/L	Phosphor-us as PO4 mg/L	Alumi-num (Al) µg/L	Cad-mium (Cd) µg/L	Copper (Cu) µg/L	Iron (Fe) µg/L	Lead (Pb) µg/L	Man-gan-ese (Mn) µg/L	Dis. organic carbon (DOC) mg/L
<.003	.05	.01	.14	.36	.03	.020	<.003	.008	3.50	.154	.704	5.2	.568	3.8	.6
<.003	.08	.03	.19	.37	<.01	.019	<.003	.007	--	.341	1.09	5.1	.532	2.2	.7
.005	.17	.13	.18	.18	<.01	.027	.034	.003	4.48	.964	2.56	8.5	1.08	1.7	1.1
.008	.05	.02	.15	.15	<.01	.023	<.003	.011	1.83	.102	.437	2.2	.640	.5	.5
<.003	.12	.03	.19	.22	.01	.12	.008	.010	2.72	.592	2.45	5.1	.928	1.7	.7
<.003	.08	.02	.19	.45	<.01	.055	<.003	.002	1.86	.147	.570	2.4	.580	.4	.4
<.003	.14	.04	.21	.36	<.01	.015	<.003	.005	1.60	.226	.632	.8	.504	.9	.5
.021	.11	.02	.19	.52	<.01	.016	<.003	<.002	3.12	.084	.526	3.6	.652	2.8	.5
.010	.19	.01	.22	.45	.03	.016	.004	.019	1.97	.128	.437	2.2	.450	.7	.6
<.003	.11	.01	.13	.12	.03	.016	.008	.009	1.26	.060	.213	.5	.499	.2	.3
<.003	.26	.04	.13	.24	.03	.016	.012	.022	3.56	.085	.259	1.1	.430	3.5	.9
<.003	.07	.01	.26	.50	.04	.022	<.003	.021	3.68	.123	.349	.9	.500	.6	.3
<.003	.15	.02	.12	.32	.04	.007	.003	.022	1.20	.055	.393	.7	.169	3.3	.6
<.003	.15	.01	.24	.28	.03	.016	.003	.019	1.20	.073	.206	.9	.342	.6	.5
<.003	.11	.01	.29	.32	.03	.014	.010	.006	3.38	.103	.160	.4	.294	.3	.5
<.003	.15	.01	.22	.21	.03	.013	.018	<.002	1.78	.071	.223	<.1	.227	<.1	.3
.004	.19	.01	.27	.17	.04	.013	.019	<.002	1.55	.095	.319	2.1	.275	.5	.3
<.003	.11	.01	.32	.17	.03	.017	.021	<.002	1.32	.108	.622	1.3	.241	.1	.5
<.003	.08	.01	.16	.31	.04	.016	.016	.002	3.00	.136	.689	1.3	.385	.2	.2
<.003	.12	.01	.15	.34	.03	.021	.024	<.002	1.75	.127	.239	<.1	.580	1.1	.8
<.003	.10	.05	.13	.22	.06	.007	.030	.007	3.44	.121	.596	.1	.592	5.4	1.1
<.003	.07	.02	.12	.30	.06	.016	.006	.003	2.97	.075	.979	1.7	.566	4.0	.7
.032	.03	.01	.13	.12	.04	.011	.16	<.002	100.	.113	.451	<.1	.288	.4	.6
.023	.06	.01	.19	.41	.03	.019	.16	<.002	3.29	.094	.661	<.1	.534	.8	.7
.025	.06	.01	.13	.40	.10	.015	.15	<.002	1.89	.220	3.79	<.1	.437	.3	.5
.020	.09	.01	.13	.30	.03	<.002	.16	<.002	1.72	.066	.462	<.1	.400	.6	.6
.014	.16	.30	.16	.40	.03	.018	.18	.021	10.3	.075	.340	<.1	.323	7.3	4.1
.013	.03	.01	.12	.25	.04	.012	.16	.002	.64	.116	.376	<.1	.379	.5	.7
.017	.07	.01	.12	.22	.04	.013	.15	<.002	1.49	.050	.305	<.1	.319	.8	.4
.019	.14	.01	.12	.21	.03	.018	.15	<.002	.70	.054	.126	<.1	.323	.7	.4
<.003	.05	.01	.12	.31	.05	.015	.15	<.002	.91	.068	.229	<.1	.286	.5	.4
.010	.06	.01	.10	.27	.04	.010	.14	<.002	.39	.047	.295	<.1	.352	.7	.6
<.003	.10	.01	.13	.21	.05	.010	.14	.002	.18	.073	.322	<.1	.261	.3	.5
<.003	.10	.01	.13	.19	.03	.007	.14	<.002	1.43	.045	.396	<.1	.235	.8	.7
.037	.09	.01	.10	.07	.05	.008	.13	.003	6.60	.073	.209	<.1	.509	1.0	.7
.013	.10	.01	.10	.10	.04	.008	.14	.002	1.92	.048	.252	<.1	.223	1.1	.7

Table 7.--Continued.

[D, duplicate sample; S, sample of surface snow; A, added sample point; T, east-west transect sample;
Specific conductance is reported in micromhos per centimeter at 25 Celsius; pH is reported in pH units;
hydrogen ion is reported as microequivalents per liter; all other constituents are reported as dissolved
in milligrams per liter.]

Sample No.	Location		Latitude	Longitude	1983 Date sampled	Altitude (m)	Snow depth (cm)	Content (cm)	Specific conductance µS/cm	pH	Hydrogen ion (H+) µeq.	Calcium (Ca) mg/L
32	The Twins	OR	43 42'03"	121 59'11"	Mar 3	1999	213	65	2.01	5.75	1.78	.019
33	Bear Mountain	OR	43 30'59"	122 14'17"	Mar 3	1804	274	94	2.11	5.52	3.02	.014
33D	Bear Mountain	OR	43 30'59"	122 14'17"	Mar 3	1804	259	79	2.17	5.51	3.09	.014
34	Sawtooth Mountain	OR	43 22'19"	122 07'51"	Mar 3	1908	389	135	1.92	5.61	2.45	.029
34S	Sawtooth Mountain	OR	43 22'19"	122 07'51"	Mar 3	1908	20	--	2.17	5.60	2.51	.027
35	Desert Cone	OR	43 02'31"	122 12'50"	Mar 6	2012	340	127	2.06	5.63	2.34	.024
36T	Timber Crater	OR	43 02'44"	122 03'21"	Mar 6	2256	305	107	2.03	5.49	3.24	.054
37	Mount Scott	OR	42 55'56"	122 01'20"	Mar 6	2380	427	145	2.24	5.69	2.04	.058
38	Maude Mountain	OR	42 42'47"	122 11'08"	Mar 6	2021	348	135	1.80	5.73	1.86	.032
39	Mount McLoughlin	OR	42 26'40"	122 17'01"	Mar 6	2060	328	112	2.10	5.61	2.45	.032
40	Buck Mountain	OR	42 10'05"	122 08'34"	Mar 6	1868	229	79	2.13	5.49	3.24	.012
41	Eagle Rock	CA	41 51'58"	122 15'20"	Mar 7	1990	224	60	2.36	5.63	2.34	.057
42	Goosenest Mtn.	CA	41 42'38"	122 14'38"	Mar 7	2121	198	56	2.64	5.54	2.88	.071
42D	Goosenest Mtn.	CA	41 42'38"	122 14'38"	Mar 7	2121	216	61	2.80	5.45	3.55	.033
43	The Whaleback	CA	41 31'47"	122 07'20"	Mar 7	2262	373	109	1.96	5.69	2.04	.071
44	Mount Shasta	CA	41 22'46"	122 14'47"	Mar 8	2438	508	94	2.45	5.69	2.04	.13
45T	Mount Shasta	CA	41 21'10"	122 14'20"	Mar 7	1768	312	--	2.64	5.44	3.63	.068
45S	Mount Shasta	CA	41 21'10"	122 14'20"	Mar 7	1768	20	--	3.18	5.36	4.37	.028
46	Grizzly Peak	CA	41 09'16"	121 58'26"	Mar 8	1798	384	147	2.42	5.55	2.82	.027
47	Chalk Mountain	CA	40 59'28"	121 48'12"	Mar 8	1737	251	88	2.01	5.58	2.63	.011
48	Burney Mountain	CA	40 48'21"	121 38'44"	Mar 8	1990	307	84	3.22	5.54	2.88	.043
49	Latour Butte	CA	40 36'25"	121 42'50"	Mar 8	2012	335	127	3.95	5.57	2.69	.032
50	Mount Lassen	CA	40 29'38"	121 33'58"	Mar 9	2432	244	95	2.32	5.69	2.04	.025
51	Turner Mountain	CA	40 17'44"	121 37'23"	Mar 9	1987	467	91	3.27	5.58	2.63	.093
52	Colby Mountain	CA	40 08'56"	121 31'33"	Mar 9	1829	236	67	2.54	5.62	2.40	.032
53	Bald Eagle Mtn.	CA	39 56'04"	121 14'02"	Mar 9	2109	467	173	3.45	5.77	1.70	.14
53D	Bald Eagle Mtn.	CA	39 56'04"	121 14'02"	Mar 9	2109	467	180	3.67	5.50	3.63	.033
54	Pilot Peak	CA	39 44'07"	120 51'21"	Mar 9	2225	630	241	2.77	5.56	2.75	.042
55	Sierra Buttes	CA	39 35'59"	120 39'31"	Mar 9	2384	554	208	2.31	5.57	2.69	.044
56T	Table Mountain	CA	39 30'43"	120 51'11"	Mar 9	1743	193	69	2.07	5.60	2.51	.025
57	Webber Peak	CA	39 29'05"	120 26'46"	Mar 9	2435	503	64	3.06	5.66	2.19	.16
58	Castle Peak	CA	39 20'43"	120 21'01"	Mar 10	2231	488	175	2.49	5.58	2.63	.036
59	Granite Chief	CA	39 11'20"	120 17'07"	Mar 10	2463	584	155	2.32	5.68	2.09	.053
60	Steamboat Mtn.	CA	39 07'20"	120 19'54"	Mar 10	2301	444	163	2.18	5.47	3.39	.020
60S	Steamboat Mtn.	CA	39 07'20"	120 19'54"	Mar 10	2301	30	--	2.44	5.43	3.72	.024
61	Nevada Pt. Ridge	CA	39 02'53"	120 26'58"	Mar 10	1866	182	66	1.82	5.55	2.82	.010

Magnesium (Mg) mg/L	Sodium (Na) mg/L	Potassium (K) mg/L	Sulfate (SO4) mg/L	Chloride (Cl) mg/L	Fluoride (F) mg/L	Nitrogen as NO3 mg/L	Nitrogen as NH4 mg/L	Phosphorus as PO4 mg/L	Aluminum (Al) µg/L	Cadmium (Cd) µg/L	Copper (Cu) µg/L	Iron (Fe) µg/L	Lead (Pb) µg/L	Manganese (Mn) µg/L	Dis. organic carbon (DOC) mg/L
<.003	.03	<.01	.08	.10	.03	.008	.13	.002	2.39	.068	.282	<.1	.214	.6	.7
<.003	.05	.01	.10	.10	.03	.009	.14	.002	1.59	.063	.350	<.1	.227	1.1	.4
.005	.06	.01	.10	.10	.03	.013	.14	<.002	1.08	.139	.319	<.1	.389	1.1	.4
<.003	.05	.01	.08	.12	.03	.010	.13	.004	1.08	.126	.216	<.1	.243	.9	.5
.004	.07	.01	.10	.06	.05	.020	.13	.007	1.38	.118	.459	<.1	.670	1.3	.4
<.003	.05	.01	.10	.08	.04	.016	.13	.006	1.41	.035	.186	<.1	.237	.6	.6
<.003	.08	.01	.05	.02	.03	.015	.12	.005	1.06	.073	.196	<.1	.253	.5	.4
<.003	.05	.01	.07	.06	.07	.022	.14	.006	1.28	.155	.292	<.1	.408	.8	.6
<.003	.07	.01	.10	.11	.01	.015	.12	.005	5.40	.119	.362	<.1	.666	.4	.4
<.003	.05	.01	.08	.12	<.01	.016	.13	.005	1.17	.066	.136	<.1	.256	.9	.4
<.003	.03	.01	.09	.08	<.01	.024	.13	.005	2.52	.052	.100	<.1	.200	.7	.4
.004	.06	.02	.15	.06	.01	.029	.13	.006	6.10	.482	.901	<.1	.771	1.6	.7
<.01	.05	.02	.09	.09	<.01	.030	.13	.007	2.13	.118	1.11	<.1	.426	.8	1.1
.005	.05	.02	.09	.08	.02	.033	.16	.011	4.54	.039	.180	.1	.253	7.8	.8
.008	.04	.01	.07	.05	.01	.023	.15	.007	1.49	.060	.393	.15	.266	.9	.6
<.003	.06	.01	.12	.06	.01	.036	.16	.006	1.03	.108	.364	<.1	.597	.6	.8
<.003	.05	.02	.15	.09	<.01	.038	.16	.005	1.62	.262	1.19	<.1	.913	.6	.6
<.003	.10	<.01	.11	.10	.01	.056	.16	.006	2.18	.121	.242	<.1	.858	.7	.4
<.003	.04	.01	.10	.11	.02	.025	.15	.005	.77	.042	.103	<.1	.318	1.1	.5
<.003	.03	.01	.07	.10	<.01	.021	.15	.006	.67	.041	.126	<.1	.204	.5	.4
<.003	.10	.04	.12	.17	<.01	.027	.15	.005	2.05	.066	.140	<.1	.271	.9	.7
<.003	.08	.01	.16	.27	.01	.037	.15	.005	.67	.074	.196	<.1	.387	.4	.5
<.003	.02	.01	.09	.10	.01	.023	.14	.009	.83	.041	.475	<.1	.254	.4	.7
<.003	.12	.01	.20	.24	.03	.037	.15	.006	1.72	.143	.335	<.1	.306	1.4	.8
<.003	.05	.01	.10	.15	<.01	.021	.15	.006	.70	.073	.273	<.1	.384	.7	.6
<.003	.23	.04	.19	.39	.02	.034	.14	.006	1.72	.048	.287	.82	.190	1.6	1.2
.010	.08	.01	.23	.38	<.01	.048	.14	.005	2.06	.202	.150	<.1	.179	1.0	.6
<.003	.07	.01	.15	.19	.01	.027	.11	.006	1.12	.134	.216	<.1	.204	.6	.5
<.003	.06	.01	.15	.18	.01	.024	.10	.0066	.76	.109	.235	<.1	.127	.5	.5
<.003	.04	.01	.17	.50	<.01	.016	.10	.0052	.62	.112	.221	<.1	.258	.4	.3
<.003	.10	.02	.19	1.01	.03	.026	.099	.0056	2.11	.162	.589	<.1	.440	1.2	1.1
<.003	.06	.01	.16	.16	<.01	.022	.10	.0075	1.86	.050	.258	<.1	.148	.4	.5
<.003	.05	.01	.15	.89	.02	.021	.092	.007	.72	.093	.298	<.1	.141	1.0	.6
.010	.01	.01	.13	.40	.02	.031	.089	.006	.69	.096	.214	.5	.180	.2	.3
<.003	.05	.03	.07	.09	.03	.038	.006	.005	9.46	.142	.393	.1	.402	.1	.5
.016	.03	.01	.04	.12	.02	.020	.053	.002	1.77	.060	.183	1.3	.064	<.1	.2

Table 7.--Continued.

[D, duplicate sample; S, sample of surface snow; A, added sample point; T, east-west transect sample;
Specific conductance is reported in micromhos per centimeter at 25 Celsius; pH is reported in pH units;
hydrogen ion is reported as microequivalents per liter; all other constituents are reported as dissolved
in milligrams per liter.]

Sample No.	Location		Latitude	Longitude	1983 Date sampled	Altitude (m)	Snow depth (cm)	Content (cm)	Specific conductance µS/cm	pH	Hydrogen ion (H+) µeq.	Calcium (Ca) mg/L
62	Bryan Meadow	CA	38 46'31"	120 04'31"	Mar 10	2390	376	102	2.52	5.63	2.34	.095
62D	Bryan Meadow	CA	38 46'31"	120 04'31"	Mar 10	2390	376	127	2.18	5.54	2.88	.02
63	Bear Creek	CA	38 36'25"	120 08'26"	Mar 11	2420	389	137	1.87	5.61	2.45	.042
63S	Bear Creek	CA	38 36'25"	120 08'26"	Mar 11	2420	20	--	2.67	5.50	3.16	.028
64	Coral Ridge	CA	38 29'33"	120 04'36"	Mar 11	2444	452	168	2.40	5.63	2.34	.042
65	Clark Fork Meadow	CA	38 19'15"	119 41'01"	Mar 11	2856	376	112	1.78	5.71	1.55	.061
66T	Kibbie Ridge	CA	38 03'44"	119 52'01"	Mar 11	2195	447	147	2.56	5.59	2.57	.035
67T	Cow Meadow	CA	38 08'07"	119 43'56"	Mar 11	2551	--	124	2.13	5.72	1.91	.05
68	Mary Lake	CA	38 08'08"	119 33'58"	Mar 12	2865	381	104	2.09	5.72	1.91	.11
69	Virginia Lake	CA	37 57'36"	119 25'11"	Mar 12	2926	310	--	1.82	5.57	2.69	.073
70	Fletcher Peak	CA	37 47'27"	119 20'40"	Mar 12	3140	330	--	2.02	5.59	2.57	.082
71T	Starr King Valley	CA	37 41'01"	119 37'18"	Mar 12	2085	312	109	2.02	5.51	3.09	.017
71DT	Starr King Valley	CA	37 41'01"	119 37'18"	Mar 12	2085	312	114	2.22	5.67	2.14	.035
72T	Yosemite N.P.	CA	37 38'41"	119 35'51"	Mar 16	2195	292	91	1.82	5.55	2.62	.008
73	Raymond Mountain	CA	37 29'33"	119 33'17"	Mar 16	2146	399	198	2.68	5.40	3.98	.008
73D	Raymond Mountain	CA	37 29'33"	119 33'17"	Mar 16	2146	399	206	2.13	5.64	2.29	.008
74	Shuteye Peak	CA	37 21'17"	119 25'46"	Mar 16	2463	475	168	2.26	5.44	3.63	.008
74A	Ward Mountain	CA	37 14'10"	118 55'06"	Mar 16	2390	211	109	2.05	5.52	3.02	.013
74AD	Ward Mountain	CA	37 14'10"	118 55'06"	Mar 16	2390	211	109	2.42	5.34	4.57	.014
75	Burnt Mountain	CA	36 57'08"	118 44'15"	Mar 16	2786	356	--	2.28	5.43	3.72	.028
76	Sentinel Peak	CA	36 45'04"	118 40'20"	Mar 15	2810	198	28	2.26	5.40	3.98	.032
76D	Sentinel Peak	CA	36 45'04"	118 40'20"	Mar 15	2810	198	30	3.26	5.47	3.39	.048
76A	Emerald Lake	CA	36 36'03"	118 41'27"	Mar 15	2838	447	76	2.29	5.42	3.80	.019
76AD	Emerald Lake	CA	36 36'03"	118 41'27"	Mar 15	2838	437	76	2.05	5.47	3.39	.01
77	Castle Rocks	CA	36 29'34"	118 40'37"	Mar 15	2463	338	119	2.35	5.43	3.72	.019
77D	Castle Rocks	CA	36 29'34"	118 40'37"	Mar 15	2463	338	109	2.31	5.50	3.16	.018
78	Summit Meadow	CA	36 20'43"	118 39'16"	Mar 15	2627	470	109	3.10	5.36	4.37	.030
78D	Summit Meadow	CA	36 20'43"	118 39'16"	Mar 15	2627	437	117	3.52	5.42	3.80	.031
79	Freezeout Meadow	CA	36 03'09"	118 34'30"	Mar 15	2576	386	64	2.95	5.80	2.34	.032
79D	Freezeout Meadow	CA	36 03'09"	118 34'30"	Mar 15	2576	406	69	2.58	5.63	2.34	.027

Magnesium (Mg) mg/L	Sodium (Na) mg/L	Potassium (K) mg/L	Sulfate (SO4) mg/L	Chloride (Cl) mg/L	Fluoride (F) mg/L	Nitrogen as NO3 mg/L	Nitrogen as NH4 mg/L	Phosphorus as PO4 mg/L	Aluminum (Al) µg/L	Cadmium (Cd) µg/L	Copper (Cu) µg/L	Iron (Fe) µg/L	Lead (Pb) µg/L	Manganese (Mn) µg/L	Dis. organic carbon (DOC) mg/L
.012	.05	.02	.12	.08	.04	.033	.022	<.002	1.72	.044	.301	.7	.214	.5	1.3
<.003	.02	.01	.07	.09	<.01	.026	.032	<.002	.79	.051	.150	.8	.129	.1	.6
<.003	<.01	.01	.13	.96	.03	.027	.028	.003	.79	.054	.548	<.1	.661	<.1	.6
<.003	.03	.01	.19	.08	.03	.044	.030	.005	1.62	.340	.819	.3	.283	<.04	.5
.016	<.01	.02	.07	.08	.02	.028	.076	.008	2.56	.037	.238	.6	.144	.2	.8
.004	.02	.01	.07	.04	<.01	.025	.036	.006	1.84	.037	.232	1.2	.070	.3	.4
.016	.03	.01	.13	.10	.02	.032	.031	.004	2.85	.038	.206	1.4	.072	.7	.6
<.003	.03	.01	.16	.05	<.01	.029	.042	.009	2.13	.077	.264	<.1	.106	<.1	.6
.007	.03	.01	.13	.03	.02	.026	.032	.004	4.11	.045	.173	.6	.194	.3	.6
.010	.02	<.01	.12	.19	.03	.021	.026	.006	3.59	.047	.130	.9	.123	.1	.5
<.003	.04	.01	.09	.01	.03	.026	.026	<.002	2.67	.037	.156	.6	.112	<.1	.5
<.003	.04	.01	.12	.06	<.01	.033	.030	<.002	.76	.035	.123	<.1	.089	.3	.4
<.003	.05	.01	.11	.06	<.01	.030	.046	<.002	.53	.036	.192	<.1	.133	.5	.4
<.003	.04	.01	.07	.07	<.01	.024	.039	<.002	1.49	.037	.123	1.1	.053	2.1	.3
<.003	.07	.01	.19	.10	.03	.038	.052	.002	1.18	.032	.126	.8	.140	.4	.4
<.003	.05	.01	.19	.10	.03	.031	.050	.002	.94	.046	.173	<.1	.121	<.1	.3
<.003	.01	.01	.13	.07	.10	.035	.039	<.002	1.34	.024	.163	.2	.089	.9	.5
.009	.02	.01	.07	.10	<.01	.033	.038	<.002	3.76	.034	.146	<.1	.165	.5	.6
<.003	<.01	.03	.06	.07	.02	.032	.027	<.002	3.76	.044	.219	<.1	.171	.5	.9
<.003	.02	.01	.07	.06	<.01	.036	.042	.003	1.21	.181	.416	.6	.276	.8	.4
<.003	.03	.02	.12	.07	.03	.040	.029	.002	4.34	.143	.416	2.0	.258	<.1	.6
.007	.09	.06	.12	.14	.03	.044	.038	.002	5.34	.399	.180	1.8	.458	1.4	.7
.009	<.01	<.01	.06	.04	<.01	.032	.032	<.002	1.82	.048	.143	.6	.182	5.1	.3
.007	<.01	.01	.10	.22	<.01	.0333	.032	<.002	1.05	.081	.233	1.4	.206	.1	.3
.004	.04	.01	.13	.08	<.01	.033	.033	<.002	.91	.038	.126	1.0	.139	.4	.4
.047	.05	.01	.10	.25	<.01	.031	.036	.002	3.24	.061	.126	.3	.096	.6	.4
<.003	.09	.01	.16	.12	.03	.047	.040	.002	1.41	.275	.970	2.8	.292	1.2	.6
.024	.11	.06	.19	.69	.04	.042	.041	<.002	2.00	.284	1.45	2.2	.406	1.1	.4
<.003	.06	.01	.13	.16	.03	.039	.055	<.002	3.96	.065	.659	2.3	.518	2.8	1.0
<.003	.07	.02	.18	.43	<.01	.043	.035	<.002	8.48	.153	.554	2.8	.319	1.4	.5