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Mount St. Helens Ash Fall in the Bull Run Watershed, Oregon, May-June 1980

U.S. GEOLOGICAL SURVEY
Open-File Report 80-593

Bull Run watershed, looking east toward Bull Run Lake and Mount Hood. Photograph courtesy of U.S. Forest Service.

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INTRODUCTION

Volcanic activity on Mount St. Helens in southwestern Washington has continued steadily since the mountain first erupted on March 27, 1980, after more than 100 years of inactivity. Periodically, gas and ash are ejected from the volcano. Volcanologists have reported that a highly viscous magma is beginning to ooze from the bottom of the mile-deep crater created by an explosive eruption on May 18, 1980 (oral commun., D. R. Crandell, U.S. Geological Survey, June 27, 1980). (See figure 1.)

Figure 1.–Mount St. Helens crater, May 22, 1980.

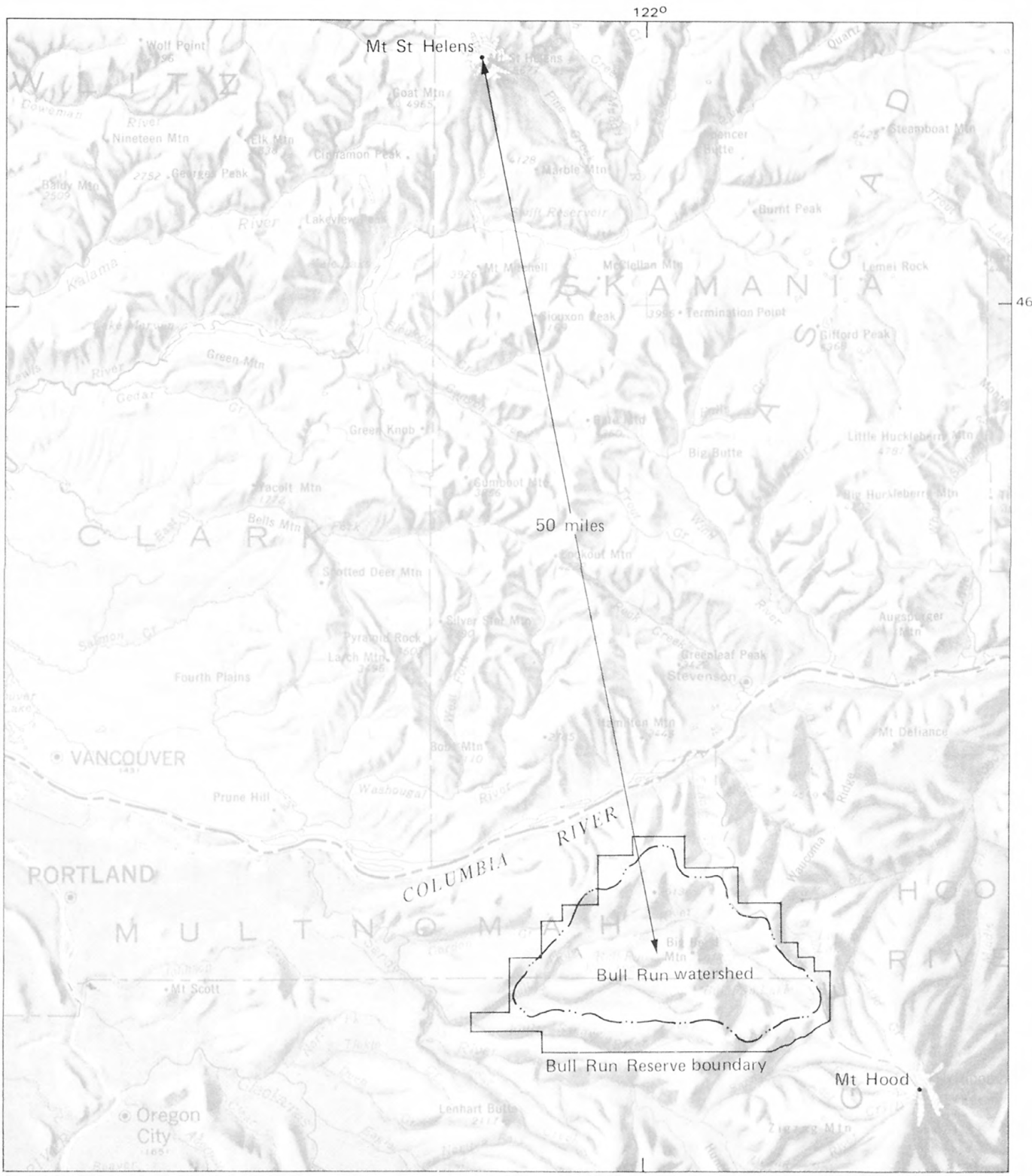


Figure 2.-Location of the Bull Run watershed and its distance from Mount St. Helens.

The 102-square-mile (264-square-kilometer) Bull Run watershed (see photograph inside front cover) is south of the Columbia River, approximately 50 mi (80 km) south of Mount St. Helens (fig. 2), and supplies water to more that 600,000 Portland area users. Because of the proximity of the mountain to the watershed, Portland residents have been concerned that ash could fall in the Bull Run watershed if a volcanic eruption occurred during a period of northerly windflow. The first such occurrence was on March 30, 1980. Precipitation and stream-quality data collected in April following this ash fall are reported by Shulters and Clifton (1980). The collection sites were integrated into a hydrologic-data network established earlier for an ongoing water-quality investigation of the Bull Run watershed.

This report presents data obtained between May 18, 1980, and June 15, 1980, at the sites shown in figure 3. Ash fall in the Bull Run watershed was noted on at least three occasions during this period. No data were collected between April 21 and the large eruption on May 18. Water analyses include temperature, pH, specific conductance, acidity, sulfate and nitrate plus nitrite.

Particle-size analyses, chemical composition, and weight of ash collected at the sampling sites are also shown.

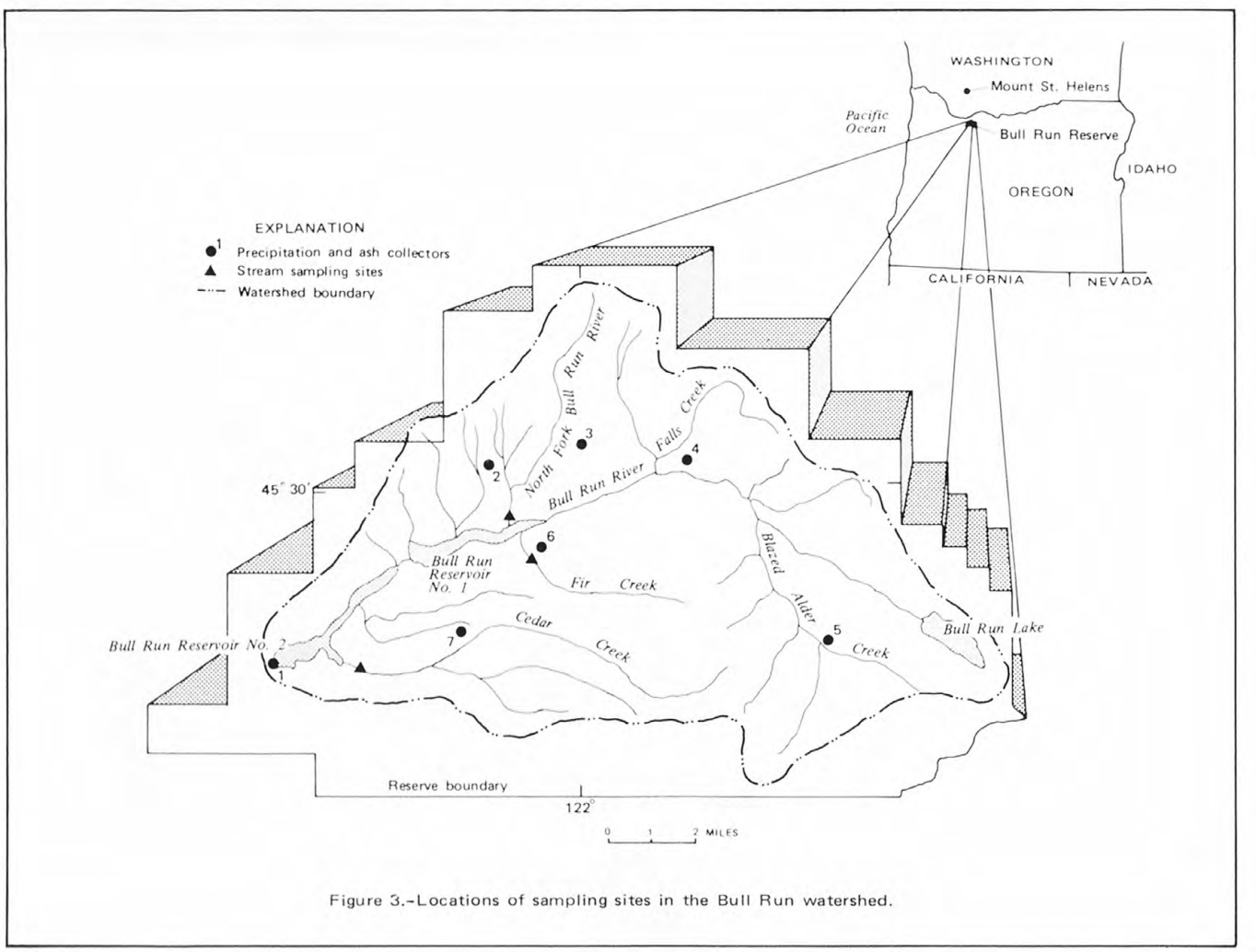


Figure 3.–Locations of sampling sites in the Bull Run watershed.

VOLCANIC EVENTS

Beginning on the morning of May 18, a cataclysmic eruption of Mount St. Helens ejected large quantities of ash which covered much of eastern Washington, northern Idaho, and western Montana. Because winds were generally from the west at that time, detectable ash fall in the Bull Run watershed did not occur. A subsequent eruption on May 25, although not as large, was accompanied by high-altitude northerly winds which transported ash into the Bull Run watershed (fig. 4). Another known ash fall occurred on June 12 and 13, when a large, sustained eruption was accompanied by high-altitude winds from the north. Ash was also deposited in the watershed between the May 28 and June 2 sampling visits (fig. 4).

DATA COLLECTION AND ANALYSIS

The precipitation and ash collectors placed on April 2, 1980, to collect data for an earlier report (Shulters and Clifton, 1980) were also used for this report. Locations of these sites are shown in figure 3. Each precipitation collector is an 8-inch (200-millimeter) plastic funnel mounted on a metal post connected to a flexible plastic tubing that conveys the precipitation to a 0.3 gallon (1-liter) sample bottle. Ash collectors are arrays of nine open-top bottles covering a total area of 48 $in.^2$ (310 cm^2). Visits to collect samples are made as required by the frequency of storms and volcanic events.

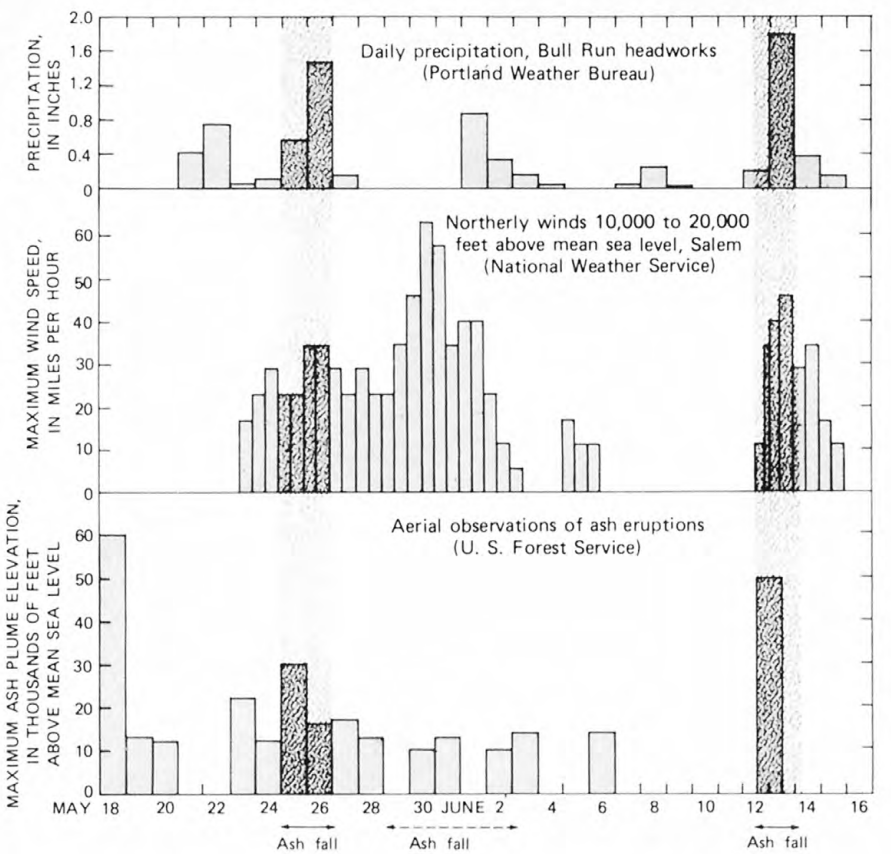


Figure 4.—Precipitation, high-altitude northerly wind speeds, and ash plume elevations during the period May 18–June 15, 1980

All field measurements and laboratory procedures for water analyses were made by methods described by Skougstad and others (1979). Stream pH values were determined for this report by immersing a glass electrode in an unstirred subsample of water obtained from a depth-integrated, cross-sectional composite sample of the stream. Precipitation pH values were measured directly using the same technique. All pH values were measured in the field except for those collected on May 27 and 28, which were determined at the U. S. Geological Survey laboratory in Portland. Stream pH values reported previously by Shulters and Clifton (1980) were measured in situ. Acidity and specific conductance were determined at the U.S. Geological Survey laboratory in Portland, and sulfate and nitrate plus nitrite were analyzed at the Survey's water-quality laboratory in Denver, Colo. The analytical results are listed in table 2.

Particle-size analyses of ash samples collected in the Bull Run watershed and in Portland are shown in table 1. Analytical procedures were those described by Guy (1969). Figure 5 shows ash particles, deposited on May 25 in Portland, magnified by a scanning electron microscope.

Ash from the May 25 fall in the Bull Run watershed was removed from collectors at each of the seven sites shown in figure 3 and then combined for analysis. This composite sample and another sample collected in Portland after the June 12 ash fall were analyzed by the U.S. Geological Survey, Branch of Analytical Laboratories, Menlo Park, Calif. Results of the analyses, shown in table 3, do not include oxygen that would be chemically bound to the elements.

Table 1.--Particle-size analyses of ash fall samples

[Size determinations by settling velocity method; ash taken from precipitation collectors]

Sample identification	Particle size, in millimeters, percent finer than									
	Sand		Silt					Clay		
	0.125	0.088	0.062	0.053	0.031	0.016	0.008	0.004	0.002	0.001
Bull Run watershed (composited sample from collectors at sites 1, 2,3,4,5,6,7 on May 25)	100	99	96	78	38	21	12	7	4	2
Portland, Oreg. (USGS District office building on June 12)	100	98	90	83	58	38	17	8	5	2

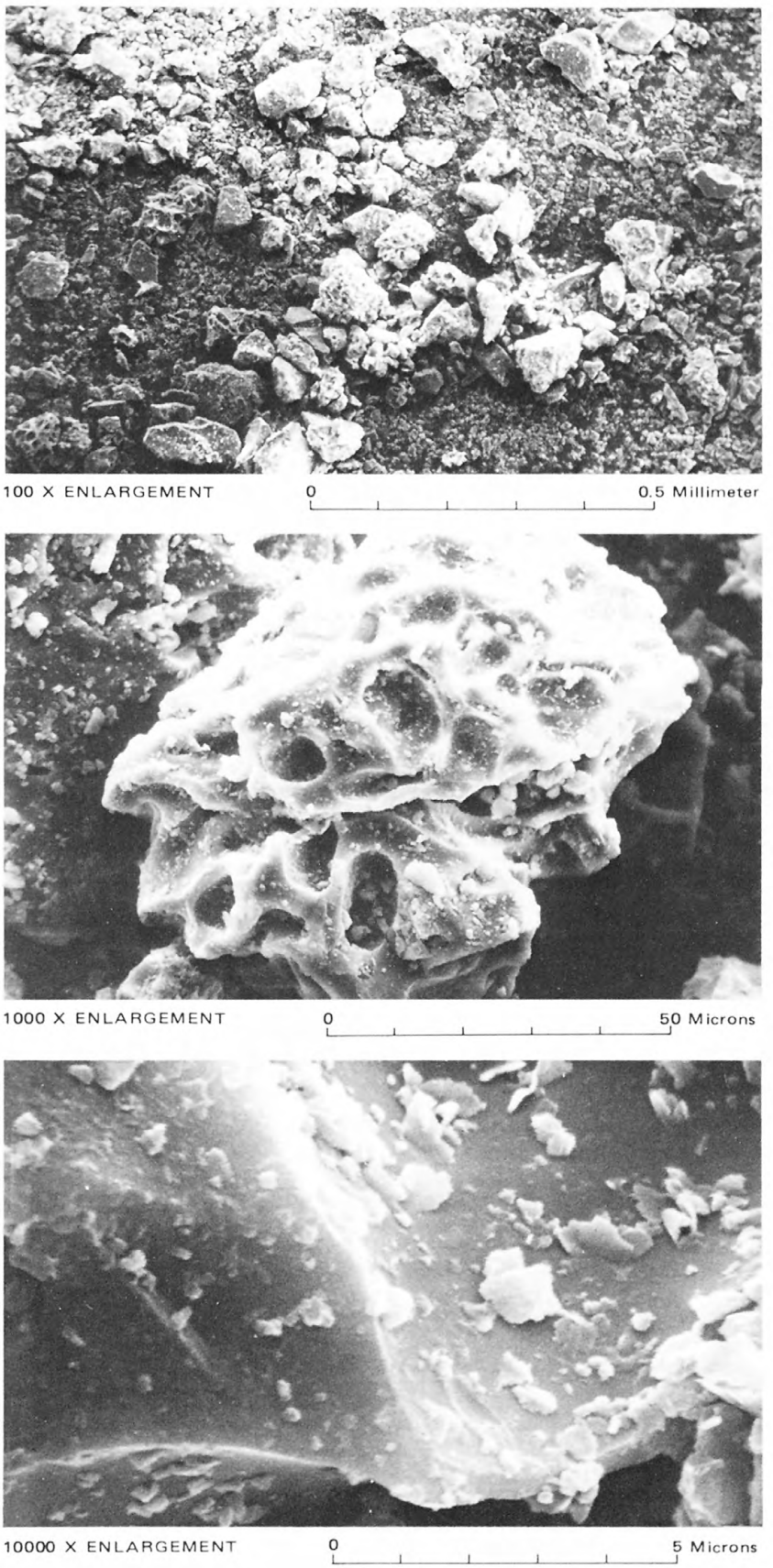


Figure 5.–Scanning-electron-microscope photographs of volcanic ash deposited in Portland, Oreg., on May 25, 1980. (Photographs courtesy of Nancy G. Temple.)

Table 2.--Analyses of precipitation and stream samples from the Bull Run watershed

[Sampling sites shown in figure 3; all chemical analyses are for dissolved constituents]

Sampling site	Sampling date or period (1980)	Water temperature (°C)	pH (units)	Specific conductance (umhos/cm at 25°C)	Acidity[1] (mg/L as $CaCO_3$)	Milligrams per liter		Weight of ash collected (milligrams per square centimeter)
						Sulfate	Nitrate + nitrite (as N)	
Precipitation samples								
1	5/19-28	17.8	5.5	12	2	1.1	0.12	--
	5/28-6/3	12.4	4.9	16	4	1.3	.17	0.38
	6/3-10	17.4	5.0	10	4	.9	.28	[2]
	6/10-13	12.0	4.0	41	10	1.3	.22	.98
2	5/19-28	17.2	5.6	9	4	.4	.07	6.10
	5/28-6/3	12.2	5.0	16	4	.4	.09	.35
	6/3-10	17.4	4.6	13	6	.3	.37	[2]
	6/10-13	12.0	4.1	31	6	.9	.14	.62
3	5/19-28	16.4	5.2	10	5	.5	.06	--
	5/28-6/3	15.0	4.8	16	5	.7	.10	.39
	6/3-10	20.6	4.8	9	6	.8	.23	[2]
	6/10-13	11.5	4.3	22	5	.4	.12	.63
4	5/19-28	20.0	5.5	7	4	.5	.07	3.20
	5/28-6/3	15.0	4.8	17	4	.6	.12	.31
	6/3-10	21.6	4.1	12	10	1.2	.33	[2]
	6/10-13	11.5	4.3	20	5	1.0	.12	.38
5	5/20-30	--	5.5	6	2	.1	.01	6.74
	5/30-6/3	13.8	5.0	11	4	.3	.05	.22
	6/3-10	18.0	4.1	39	12	--	--	[2]
	6/10-13	13.0	4.3	21	6	.1	.10	.05
6	5/19-27	11.6	5.4	8	4	1.1	.08	--
	5/27-6/4	15.2	4.7	17	5	1.3	.18	.44
	6/4-11	17.0	4.2	17	5	.7	.22	[2]
	6/11-13	12.5	4.1	35	7	.7	.17	.36
7	5/19-27	11.8	5.4	9	4	.7	.07	--
	5/27-6/4	17.4	4.8	16	5	.9	.18	.34
	6/4-11	17.4	4.1	33	12	.8	.28	[2]
	6/11-13	13.5	4.1	33	6	.6	.20	.76
Stream samples								
North Fork Bull Run River	5/28	7.8	7.4	22	1	.3	.002	
	6/3	9.0	7.4	23	1	.7	.000	
	6/6	7.7	7.5	26	5	--	--	
	6/10	9.8	7.4	28	1	.1	.001	
	6/13	14.0	7.1	22	1	1.8	.02	
South Fork Bull Run River	5/27	6.4	7.2	21	2	.7	.005	
	6/4	14.4	7.0	22	5	2.1	.003	
	6/11	10.0	7.3	27	2	1.3	.01	
	6/13	14.0	7.2	25	2	.6	.02	
Fir Creek	5/27	5.4	7.2	18	2	1.6	.01	
	6/4	9.8	6.8	19	1	.8	.01	
	6/11	8.4	6.7	22	1	.6	.000	
	6/13	14.0	7.2	21	2	.7	.04	

[1] Acidity titrations were carried to an end point pH of 8.3. See American Public Health Association and others (1971) for additional information.

[2] Ash not observed in sample.

Table 3.--Quantitative analyses of volcanic ash from the Bull Run watershed and from Portland, Oreg.

[Analyses by P. Klock, C. Heropoulos, T. Fries, and S. Neil, Branch of Analytical Laboratories, Menlo Park, Calif., using emission spectroscopy by direct reader]

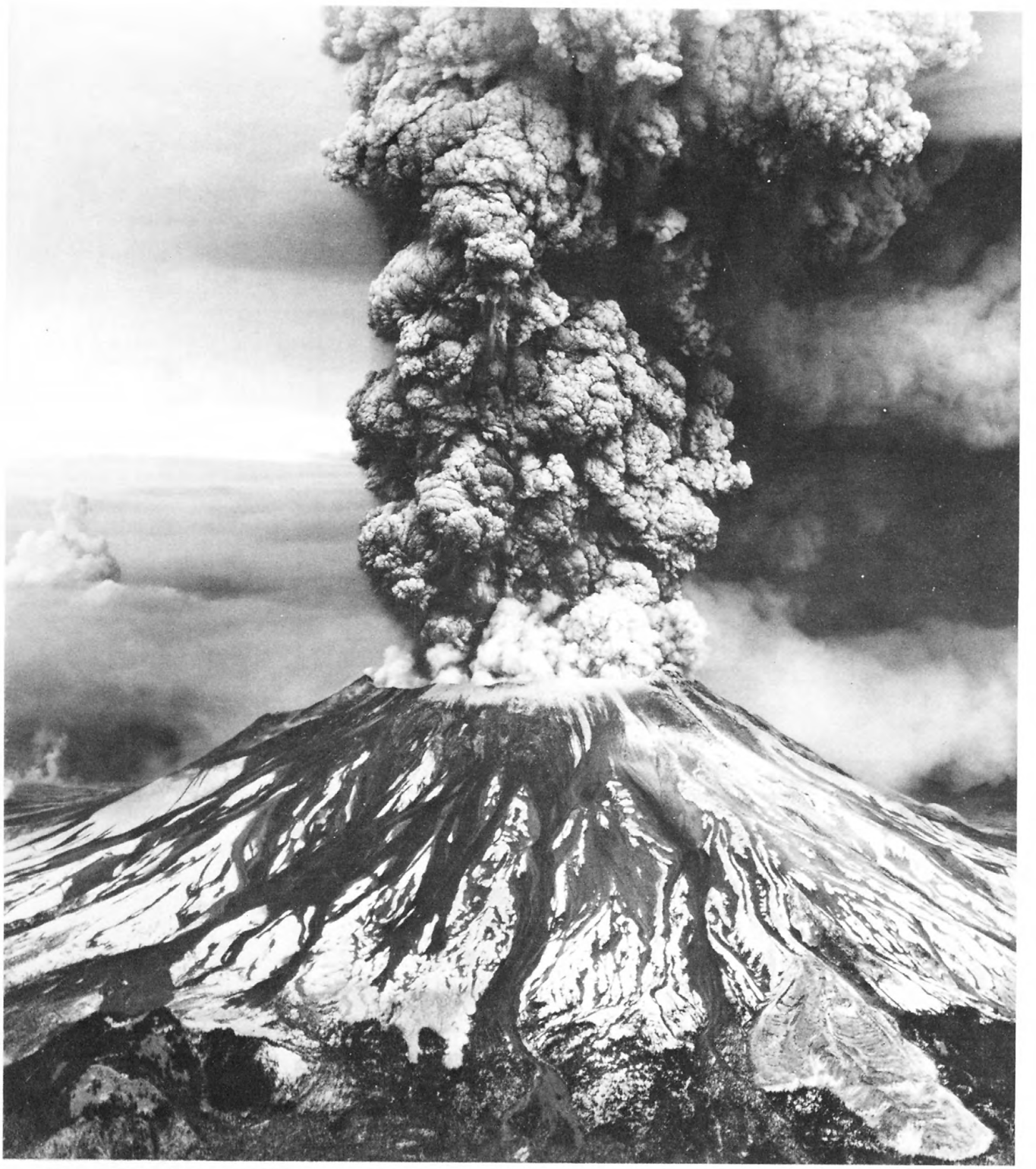
	Bull Run watershed composite sample (stations 1 through 7)	Portland, Oreg.
Percentage of sample, by weight (precision is ±15 percent)		
Iron (Fe)	3.9	3.6
Magnesium (Mg)	1.1	1.3
Calcium (Ca)	3.9	3.5
Titanium (Ti)	.46	.42
Silicon (Si)	32	30
Aluminum (Al)	9.8	8.6
Sodium (Na)	3.6	2.7
Potassium (K)	1.8	1.6
Phosphorus (P)	.09	.08
Sulfur (S)[1/]	.10	.06
Parts per million (ppm) of sample, by weight (precision is ±5 percent)		
Manganese (Mn)	570	580
Arsenic (As)	3	2
Boron (B)	17	10
Barium (Ba)	410	330
Beryllium (Be)	2.1	1.9
Cadmium (Cd)	1	<.2
Cobalt (Co)	12	12
Chromium (Cr)	17	13
Copper (Cu)	39	38
Nickel (Ni)	20	15
Lead (Pb)	20	14
Scandium (Sc)	11	11
Strontium (Sr)	530	420
Vanadium (V)	94	89
Yttrium (Y)	19	15
Zinc (Zn)	77	57
Zirconium (Zr)	250	140
Gallium (Ga)	21	18

Constituents below detection levels shown, in all samples

Silver (Ag)	<1.0	Tin (Sn)	<10	Lanthanum (La)	<20
Bismuth (Bi)	<.2	Tellurium (Te)	<50	Lithium (Li)	<50
Molybdenum (Mo)	<10	Wolfram (W)	<100	Rhenium (Re)	<50
Niobium (Nb)	<25	Cerium (Ce)	<100	Thallium (Tl)	<1
Antimony (Sb)	<1	Gold (Au)	<.2	Selenium (Se)	<5

1/ Precision is ±1 percent for sulfur analyses using wet chemical methods.

Large ash plume issuing from Mount St. Helens on the afternoon of May 18, 1980.



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