UNITED STATES DEPARTMENT OF THE INTERIOR

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Analytical Results and Sample Locality Map of Stream-Sediment, Heavy-Mineral-Concentrate, and Rock Samples from the South Fork and Sand Hollow Wilderness Study Areas, Crook County, Oregon

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STUDIES RELATED TO WILDERNESS

Bureau of Land Management Wilderness Study Areas

The Federal Land Policy and Management Act (Public Law 94-579, October 21, 1976) requires the U.S. Geological Survey and the U.S. Bureau of Mines to conduct mineral surveys on certain areas to determine their mineral values, if any. Results must be made available to the public and be submitted to the President and the Congress. This report presents the results of a geochemical survey of the South Fork (OR-005-033) and Sand Hollow (OR-005-035) Wilderness Study Areas, Crook County, Oregon.

INTRODUCTION

In May 1986, and May 1987, the U.S. Geological Survey conducted a reconnaissance geochemical survey of the South Fork and Sand Hollow Wilderness Study Areas, Crook County, Oregon.

The South Fork and Sand Hollow Wilderness Study Areas comprise about 26.6 mi^2 (69.1 km^2) and 13 mi^2 (33.8 km^2), respectively, in the southeastern part of Crook County, Oregon, and lie about 41 mi (66 km) southeast of Pri1xville, Oregon, and about 7 mi (11 km) southwest of Paulina, Oregon (fig. 1). Access to the study areas is provided on the west by an all weather county road, which runs along the western boundary of the Sand Hollow Study Area and the southwestern boundary of the South Fork Study Area and joins U.S. Highway 20, about 21 mi (34 km) to the south. Access to the east side of the South Fork Study Area is provided by an unimproved dirt road, which runs along the eastern boundary of that area. The study areas are separated by a graded dirt road. Further access to the study areas is provided by various unimproved dirt roads and jeep or four-wheel drive roads.

The study areas are underlain predominately by volcanic rocks including basalts and tuffs. The oldest unit that crops out in most of the area is the middle Miocene Picture Gorge Basalt of the Columbia River Group. Interbedded with, and overlying the Picture Gorge Basalt, are tuffaceous, fine-grained sandstones and siltstones. Two thin ash-flow tuffs overlie the tuffaceous sedimentary rocks. The lowermost tuff is the Devine Canyon ash-flow tuff and the upper tuff is the Rattlesnake ash-flow tuff. The Rattlesnake tuff is overlain by several thin flows of basalt, the Basalt of Twelvemile Table, in the eastern part of the Sand Hollow Study Area. Parts of the study areas are included in geologic maps by Walker and others (1967), Walker (1977), Swanson (1969), and Greene and others (1972).

The topographic relief of the two adjoining areas is about 1,126 ft (343 m) with a maximum elevation of 4,986 ft (1,520 m) on Steens Ridge. The South Fork of Crooked River has cut a deep canyon 600 to 700 ft deep in the South Fork Study Area. East of the canyon the ground surface is rather flat and is named Twelvemile Table. To the west of the canyon are ridges and rolling hills cut by streams. The climate is semiarid.

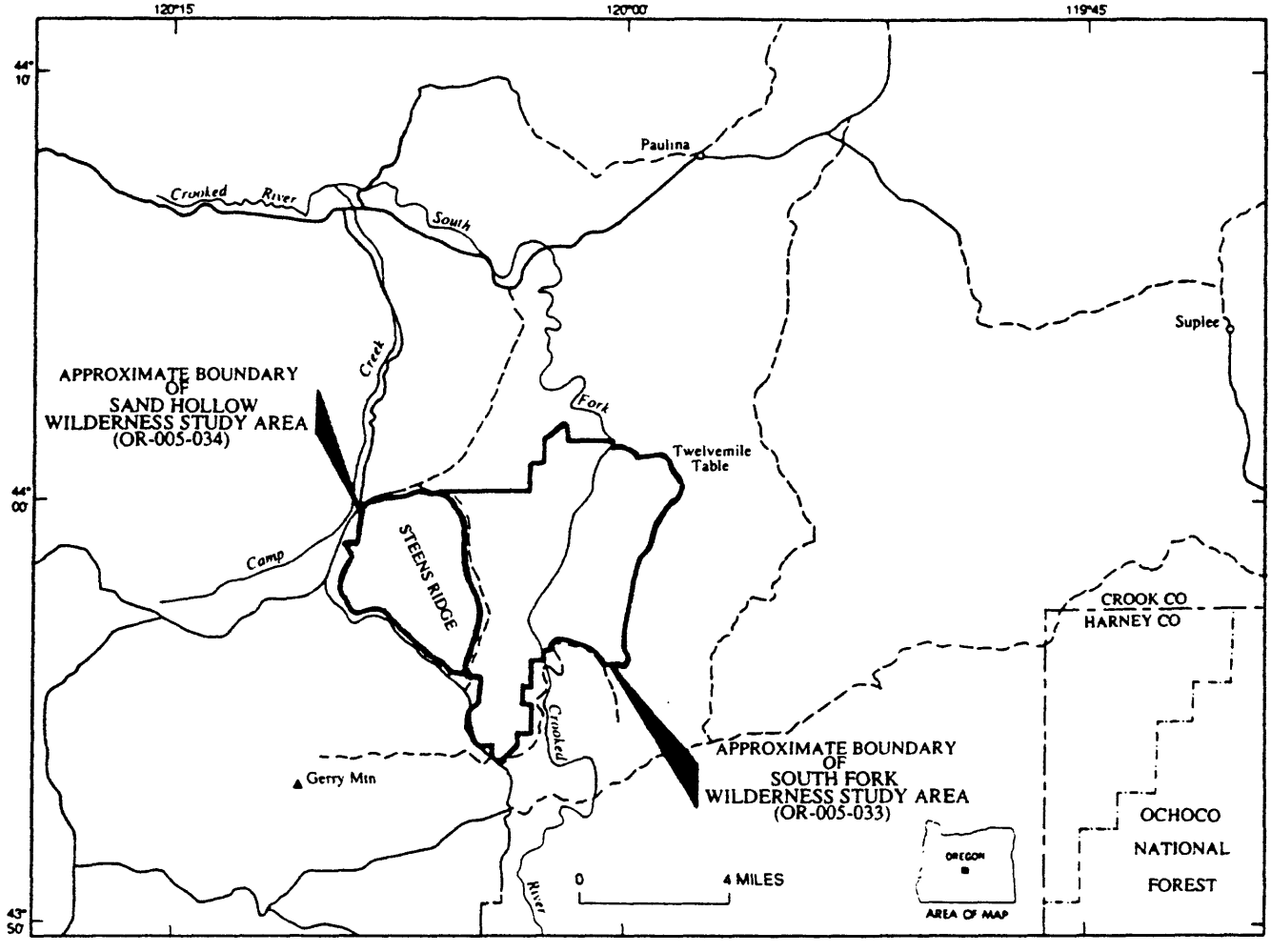

Figure 1. Location of the South Fork and Sand Hollow Wilderness Study Areas, Crook County, Oregon.

METHODS OF STUDY

Sample Media

Analyses of the stream-sediment samples represent the chemistry of the rock material eroded from the drainage basin upstream from each sample site. Such information is useful in identifying those basins which contain concentrations of elements that may be related to mineral deposits. Heavy-mineral-concentrate samples provide information about the chemistry of certain minerals in rock material eroded from the drainage basin upstream from each sample site. The selective concentration of minerals, many of which may be ore related, permits determination of some elements that are not easily detected in stream-sediment samples.

Analyses of unaltered or unmineralized rock samples provide background geochemical data for individual rock units. On the other hand, analyses of altered or mineralized rocks, where present, may provide useful geochemical information about the major- and trace-element assemblages associated with a mineralizing system.

Sample Collection

In the South Fork Wilderness Study Area, stream-sediment samples were collected at 26 sites, nonmagnetic heavy-mineral-concentrate samples were collected at 25 of the same sites, and rock samples were collected at two sites (plate 1). Sampling density was about one sample site per mi^2 for the stream sediments and heavy-mineral concentrates. The area of the drainage basins sampled ranged from 0.1 mi^2 to 4 mi^2.

In the Sand Hollow Wilderness Study Area, stream-sediment samples were collected at 23 sites, nonmagnetic heavy-mineral-concentrate samples were collected at 13 of the same sites, and rock sample were collected at 12 sites (plate 1). Sampling density was about one sample site per 0.6 mi^2 for the stream sediments. The area of the drainage basins samples ranged form about 0.15 to 2.5 mi^2.

Stream-sediment samples

The stream-sediment samples consisted of active alluvium collected primarily from first-order (unbranched) and second-order (below the junction of two first-order) streams as shown on USGS topographic maps (scale = 1:24,000) (plate 1). Each sample was composited from several localities within an area that may extend as much as 20 ft from the center of the site symbol plotted on the map.

Heavy-mineral-concentrate samples

Heavy-mineral-concentrate samples were collected from the same alluvium as the stream-sediment samples. Each bulk sample was screened with a 2.0-mm (10-mesh) screen to remove the coarse material. The less than 2.0-mm fraction was panned until most of the quartz, feldspar, organic material, and clay-sized material were removed.

Rock samples

Rock samples were collected from various types of occurrences in the vicinity of the plotted site location. Descriptions of rock samples are in table 6.

Sample Preparation

The stream-sediment samples were air dried, then sieved using 80-mesh (0.17-mm) stainless-steel sieves. The portion of the sediment passing through the sieve was saved for analysis.

Samples that had been panned in the field were air dried and sieved to -35 mesh; bromoform (specific gravity 2.85) was used to remove the remaining quartz and feldspar. The resultant heavy-mineral sample was separated into three fractions using a large electromagnet (in this case a modified Frantz Isodynamic Separator). The most magnetic material (removed at a setting of 0.25 ampere), primarily magnetite, was not analyzed. The second fraction (removed at a setting of 1.75 ampere), largely ferromagnesian silicates and iron oxides, was saved for archival storage. The third fraction (the nonmagnetic material which may include the nonmagnetic ore minerals, zircon, sphene, etc.) was split using a Jones splitter. One split was hand ground for spectrographic analysis; the other split was saved for mineralogical analysis. (These magnetic separates are the same separates that would be produced by using a Frantz Isodynamic Separator set at a slope of 15° and a tilt of 10° with a current of 0.2 ampere to remove the magnetite and ilmenite, and a current of 0.6 ampere to split the remainder of the sample into paramagnetic and nonmagnetic fractions.)

Rock samples were crushed and then pulverized to minus 0.15 mm with ceramic plates.

Sample Analysis

Spectrographic method

The stream-sediment, heavy-mineral-concentrate, and rock samples were analyzed for 31 elements using a semiquantitative, direct-current arc emission spectrographic method (Grimes and Marranzino, 1968). The elements analyzed and their lower limits of determination are listed in table 1. Spectrographic results were obtained by visual comparison of spectra derived from the sample against spectra obtained from standards made from pure oxides and carbonates. Standard concentrations are geometrically spaced over any given order of magnitude of concentration as follows: 100, 50, 20, 10, and so forth. Samples whose concentrations are estimated to fall between those values are assigned values of 70, 30, 15, and so forth. The precision of the analytical method is approximately plus or minus one reporting interval at the 83 percent confidence level and plus or minus two reporting intervals at the 96 percent confidence level (Motooka and Grimes, 1976). Values determined for the major elements, iron, magnesium, calcium, and titanium, are given in weight percent; all others are given in parts per million (micrograms/gram). Analytical data for samples from the South Fork and Sand Hollow Wilderness Study Areas are listed in tables 3, 4, and 5.

Chemical methods

Samples from these study areas were also analyzed by other analytical methods. Rocks and stream sediments from the South Fork Wilderness Study Area were analyzed for arsenic, bismuth, cadmium, antimony, and zinc using inductively coupled plasma-atomic absorption spectroscopy (ICP-AES) and for mercury and gold using atomic absorption spectroscopy (AA). Selected stream sediments and rocks from the Sand Hollow Wilderness Study Area were also analyzed for arsenic, bismuth, cadmium, antimony, and zinc using inductively couple plasma-atomic absorption spectroscopy (ICP-AES) and for mercury using atomic absorption spectroscopy. These selected stream sediments and rocks were a follow-up study for a mercury anomaly. See table 2 for a more detailed summary of these other chemical methods used.

Analytical results for stream-sediment, heavy-mineral-concentrate, and rock samples are listed in tables 4, 5, and 6, respectively.

DATA STORAGE SYSTEM

Upon completion of all analytical work, the analytical results were entered into the Branch of Geochemistry's computer data base. This data base contains both descriptive geological information and analytical data. Any or all of this information may be retrieved and converted to a binary form (STATPAC) for computerized statistical analysis or publication (VanTrump and Miesch, 1977).

DESCRIPTION OF DATA TABLES

Tables 4-6 list the results of analyses for the samples of stream sediment, heavy-mineral concentrate, and rock, respectively. For the three tables, the data are arranged so that column 1 contains the USGS-assigned sample numbers. These numbers correspond to the numbers shown on the site location map (plate 1). Columns in which the element headings show the letter "s" below the element symbol are six-step semiquantitative emission spectrographic analyses; "aa" indicates atomic absorption analyses; and "icp" indicates inductively coupled plasma-atomic emission spectroscopy. A letter "N" in the tables indicates that a given element was looked for but not detected at the lower limit of determination shown for that element in table 1. For emission spectrographic analyses, a "less than" symbol (<) entered in the tables in front of the lower limit of determination indicates that an element was observed but was below the lowest reporting value. For AA and ICP analyses, a "less than" symbol (<) entered in the tables in front of the lower limit of determination indicates that an element was below the lowest reporting value. If an element was observed but was above the highest reporting value, a "greater than" symbol (>) was entered in the tables in front of the upper limit of determination. If an element was not looked for in a sample, two dashes (--) are entered in tables 4-6 in place of an analytical value. Because of the formatting used in the computer program that produced tables 4-6, some of the elements listed in these tables (Fe, Mg, Ca, Ti, Ag, and Be) carry one or more

nonsignificant digits to the right of the significant digits. The analysts did not determine these elements to the accuracy suggested by the extra zeros.

ACKNOWLEDGMENTS

A number of our colleagues also participated in the analyses of these samples. We would like to extend our appreciation to these colleagues -- Bryan Anderson, Paul Briggs, Suzi Erickson, Carol Gent, Phil Hageman, Tom McCollum, and Eric Welsch.

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TABLE 1.--Limits of determination for the spectrographic analysis of rocks and stream sediments, based on a 10-mg sample

[The spectrographic limits of determination for heavy-mineral-concentrate samples are based on a 5-mg sample, and are therefore two reporting intervals higher than the limits given for rocks and stream sediments]

Elements	Lower determination limit	Upper determination limit
	Percent	
Iron (Fe)	0.05	20
Magnesium (Mg)	.02	10
Calcium (Ca)	.05	20
Titanium (Ti)	.002	1
	Parts per million	
Manganese (Mn)	10	5,000
Silver (Ag)	0.5	5,000
Arsenic (As)	200	10,000
Gold (Au)	10	500
Boron (B)	10	2,000
Barium (Ba)	20	5,000
Beryllium (Be)	1	1,000
Bismuth (Bi)	10	1,000
Cadmium (Cd)	20	500
Cobalt (Co)	5	2,000
Chromium (Cr)	10	5,000
Copper (Cu)	5	20,000
Lanthanum (La)	20	1,000
Molybdenum (Mo)	5	2,000
Niobium (Nb)	20	2,000
Nickel (Ni)	5	5,000
Lead (Pb)	10	20,000
Antimony (Sb)	100	10,000
Scandium (Sc)	5	100
Tin (Sn)	10	1,000
Strontium (Sr)	100	5,000
Vanadium (V)	10	10,000
Tungsten (W)	50	10,000
Yttrium (Y)	10	2,000
Zinc (Zn)	200	10,000
Zirconium (Zr)	10	1,000
Thorium (Th)	100	2,000

TABLE 2.--Chemical methods used

[AA = atomic absorption and ICP = inductively coupled plasma spectroscopy]

Element or constituent determined	Sample type	Method	Determination limit (micrograms/ gram or ppm)	Reference
Gold (Au)	sediments and rocks	AA	.1	Modification of Thompson and others, 1968.
Mercury (Hg)	sediments and rocks	AA	.02	Koirtyohann and Khalil, 1976.
Arsenic (As)	sediments and rocks	ICP	5	Crock and others, 1987.
Antimony (Sb)		ICP	2	
Bismuth (Bi)		ICP	2	
Cadmium (Cd)		ICP	.1	
Zinc (Zn)		ICP	2	

Table 3. Description of rock samples

SF014SR1	epidotized basalt clast
SF014SR2	chalcedony, includes petrified wood
SH007JR	basalt, Picture Gorge Basalt
SH009JR	light gray, tuffaceous sandstone
SH021R	basalt, Picture Gorge Basalt
SH022R	welded rhyolite ash-flow tuff
SH023R	tuffaceous sandstone
SH024R	tuffaceous sandstone
SH025R	welded rhyolite ash-flow tuff
SH026R	welded rhyolite ash-flow tuff
SH028R	welded rhyolite ash-flow tuff
SH030R	cristobalite
SH031R	welded rhyolite ash-flow tuff
SH032R	densely-welded rhyolite ash-flow tuff, fractured, with fine quartz veinlets

Table 4A. Results of analyses of stream-sediment samples from the South Fork and Sand Hollow Wilderness Study Areas, Crook County, Oregon.

Sample	Latitude	Longitude	Fe-pct. s	Mg-pct. s	Ca-pct. s	Ti-pct. s	Mn-ppm s	Ag-ppm s	As-ppm s	Au-ppm s	B-ppm s	Ba-ppm s
SF001J	43 57 43	120 4 0	5	1.5	2.0	1.0	1,000	N	N	N	15	300
SF002S	43 56 51	120 3 17	7	2.0	2.0	>1.0	1,000	N	N	N	20	500
SF003J	43 57 45	120 3 54	5	2.0	1.5	1.0	1,000	N	N	N	15	300
SF004S	43 56 55	120 3 7	7	3.0	2.0	>1.0	1,500	N	N	N	15	500
SF005J	43 57 20	120 3 30	7	2.0	2.0	>1.0	1,000	N	N	N	20	300
SF006S	43 57 5	120 3 26	10	3.0	2.0	>1.0	1,000	N	N	N	20	500
SF007J	43 57 56	120 2 54	7	2.0	2.0	1.0	1,000	N	N	N	50	500
SF008S	43 59 39	120 5 12	20	3.0	3.0	>1.0	1,000	N	N	N	10	500
SF009J	43 58 16	120 2 27	5	1.5	1.0	.5	1,000	N	N	N	30	200
SF010S	44 0 26	120 4 48	5	1.5	1.0	.7	1,000	N	N	N	30	200
SF011J	43 58 23	120 2 30	5	1.5	1.5	.7	1,000	N	N	N	20	300
SF013J	44 2 2	120 3 17	10	2.0	5.0	1.0	1,500	N	N	N	15	500
SF015J	44 1 57	120 1 34	10	3.0	3.0	1.0	1,500	N	N	N	20	300
SF016S	44 2 16	120 1 53	5	3.0	5.0	>1.0	1,000	N	N	N	10	500
SF018S	43 59 13	120 2 42	10	2.0	2.0	>1.0	1,500	N	N	N	20	500
SF019J	44 1 22	120 2 32	5	2.0	2.0	1.0	1,000	N	N	N	15	300
SF020S	43 59 4	120 1 57	5	1.5	1.5	1.0	1,000	N	N	N	50	500
SF021J	43 59 48	120 1 20	7	1.5	2.0	1.0	1,000	N	N	N	30	300
SF022S	43 56 13	120 1 58	7	1.5	2.0	1.0	1,500	N	N	N	50	500
SF023J	43 59 37	120 2 3	7	1.5	2.0	1.0	1,000	N	N	N	30	300
SF024S	43 55 38	120 2 50	15	2.0	2.0	>1.0	1,000	N	N	N	15	500
SF025J	43 54 30	120 2 56	5	1.5	2.0	1.0	1,000	N	N	N	30	300
SF026S	43 54 8	120 4 25	10	2.0	2.0	>1.0	1,000	N	N	N	30	500
SF027J	43 55 38	120 5 3	15	2.0	3.0	>1.0	1,500	N	N	N	30	500
SF028S	43 54 13	120 4 32	10	2.0	3.0	1.0	1,000	N	N	N	30	300
SF029HS	44 1 30	120 0 27	7	1.5	3.0	.7	1,000	N	N	N	30	500
SH001JS	43 59 30	120 8 49	5	1.5	2.0	>1.0	1,000	N	N	N	30	500
SH002SS	43 57 13	120 6 12	20	5.0	2.0	>1.0	2,000	N	N	N	20	300
SH003JS	43 59 11	120 8 53	3	1.0	2.0	1.0	1,000	N	N	N	20	300
SH004SS	43 57 5	120 7 27	10	2.0	2.0	>1.0	1,500	N	N	N	20	500
SH005JS	43 57 28	120 9 13	7	1.5	2.0	1.0	1,500	N	N	N	15	500
SH006SS	43 57 9	120 7 34	20	3.0	2.0	>1.0	2,000	N	N	N	30	300
SH007JS	43 59 56	120 8 23	7	2.0	2.0	1.0	1,000	N	N	N	10	500
SH008SS	43 56 48	120 7 3	10	2.0	2.0	1.0	1,000	N	N	N	15	500
SH009JS	44 0 17	120 7 2	7	2.0	2.0	>1.0	1,000	N	N	N	15	500
SH010SS	43 57 58	120 4 54	20	3.0	1.5	>1.0	2,000	N	N	N	20	300
SH011JS	44 0 12	120 6 17	5	2.0	2.0	1.0	1,000	N	N	N	20	500
SH012SS	43 59 36	120 5 16	20	3.0	3.0	>1.0	2,000	N	N	N	20	500
SH013JS	43 56 18	120 6 22	10	2.0	2.0	1.0	1,500	N	N	N	20	500

Table 4A. Results of analyses of stream-sediment samples from the South Fork and Sand Hollow Wilderness Study Areas, Crook County, Oregon.--Continued

Sample	Be-ppm s	Bi-ppm s	Cd-ppm s	Co-ppm s	Cr-ppm s	Cu-ppm s	La-ppm s	Mo-ppm s	Nb-ppm s	Ni-ppm s	Pb-ppm s	Sb-ppm s	Sc-ppm s	Sn-ppm s
SF001J	1	N	N	20	70	30	<20	N	N	30	15	N	20	N
SF002S	1	N	N	20	100	50	<20	N	N	70	20	N	20	N
SF003J	1	N	N	20	20	30	<20	N	N	30	20	N	15	N
SF004S	<1	N	N	30	150	50	<20	N	<20	70	20	N	20	N
SF005J	<1	N	N	20	70	50	<20	N	N	30	20	N	20	N
SF006S	<1	N	N	30	100	50	<20	N	N	50	20	N	20	N
SF007J	1	N	N	20	100	50	30	N	<20	30	20	N	20	N
SF008S	<1	N	N	50	100	70	<20	N	N	50	20	N	20	N
SF009J	<1	N	N	15	50	30	<20	N	N	50	20	N	10	N
SF010S	<1	N	N	15	100	30	<20	N	N	50	20	N	15	N
SF011J	<1	N	N	15	50	20	<20	N	N	30	15	N	15	N
SF013J	<1	N	N	30	200	50	<20	N	N	50	20	N	20	N
SF015J	<1	N	N	30	500	70	<20	N	N	70	20	N	20	N
SF016S	<1	N	N	30	200	30	<20	N	N	30	15	N	20	N
SF018S	1	N	N	30	50	50	30	N	N	30	20	N	15	N
SF019J	<1	N	N	20	150	50	<20	N	N	30	<10	N	15	N
SF020S	1	N	N	15	70	30	30	N	<20	50	20	N	15	N
SF021J	1	N	N	20	100	50	<20	N	N	30	30	N	15	N
SF022S	1	N	N	20	100	30	<20	N	N	20	20	N	15	N
SF023J	1	N	N	20	50	50	<20	N	<20	20	20	N	15	N
SF024S	1	N	N	30	100	50	<20	N	N	50	15	N	15	N
SF025J	1	N	N	15	50	15	<20	N	N	15	15	N	15	N
SF026S	1	N	N	30	70	50	<20	N	<20	30	30	N	20	N
SF027J	1	N	N	30	100	50	<20	N	N	30	20	N	20	N
SF028S	<1	N	N	20	70	30	<20	N	N	30	15	N	20	N
SF029HS	1	N	N	20	70	70	100	N	N	20	20	N	20	N
SH001JS	1	N	N	20	100	30	<20	N	N	30	20	N	15	N
SH002SS	<1	N	N	50	150	50	<20	N	N	50	15	N	30	N
SH003JS	1	N	N	7	20	30	<20	N	N	15	15	N	15	N
SH004SS	1	N	N	30	70	30	<20	N	N	50	20	N	20	N
SH005JS	1	N	N	20	100	50	<20	N	N	20	30	N	20	N
SH006SS	N	N	N	50	100	50	<20	N	N	30	10	N	30	N
SH007JS	1	N	N	20	100	50	<20	N	N	30	15	N	20	N
SH008SS	<1	N	N	30	70	50	<20	N	N	30	20	N	20	N
SH009JS	<1	N	N	20	100	70	<20	N	N	50	10	N	20	N
SH010SS	N	N	N	50	150	70	<20	N	N	50	<10	N	30	N
SH011JS	<1	N	N	20	100	50	<20	N	N	50	15	N	15	N
SH012SS	N	N	N	50	200	100	<20	N	N	50	15	N	20	N
SH013JS	<1	N	N	20	70	30	<20	N	N	30	15	N	15	N

Table 4A. Results of analyses of stream-sediment samples from the South Fork and Sand Hollow Wilderness Study Areas, Crook County, Oregon.--Continued

Sample	Sr-ppm s	V-ppm s	W-ppm s	Y-ppm s	Zn-ppm s	Zr-ppm s	Th-ppm s	Au-ppm aa	Hg-ppm inst	As-ppm aa	Bi-ppm aa	Cd-ppm aa	Sb-ppm aa	Zn-ppm aa
SF001J	500	200	N	20	<200	300	N	<.1	.55	<5	<2	<.1	<2	47
SF002S	500	200	N	30	<200	200	N	<.1	.02	<5	<2	.2	<2	57
SF003J	300	200	N	20	<200	300	N	<.1	.12	<5	<2	3.9	<2	61
SF004S	500	300	N	30	<200	200	N	<.1	.05	<5	<2	.1	<2	73
SF005J	500	300	N	20	<200	200	N	--	.05	<5	<2	<.1	<2	60
SF006S	500	300	N	30	<200	200	N	<.1	.23	<5	<2	.2	<2	70
SF007J	500	150	N	30	<200	150	N	<.1	.04	<5	<2	<.1	<2	66
SF008S	500	300	N	15	<200	100	N	<.1	<.02	<5	<2	.8	<2	110
SF009J	300	150	N	20	<200	150	N	<.1	.16	<5	<2	.4	<2	58
SF010S	300	150	N	20	<200	100	N	<.1	.19	<5	<2	.3	<2	67
SF011J	500	200	N	20	<200	100	N	<.1	.06	<5	<2	<.1	<2	49
SF013J	500	300	N	20	<200	100	N	<.1	.04	<5	<2	.2	<2	62
SF015J	500	500	N	15	<200	70	N	<.1	.02	<5	<2	.6	<2	110
SF016S	500	500	N	20	N	100	N	<.1	.28	<5	<2	.4	<2	57
SF018S	300	200	N	50	N	150	N	<.1	<.02	<5	2	<.1	<2	77
SF019J	300	200	N	15	N	100	N	<.1	.06	<5	<2	.2	<2	68
SF020S	200	150	N	20	N	150	N	<.1	.05	<5	<2	.4	<2	61
SF021J	300	150	N	20	N	100	N	<.1	.04	<5	<2	.4	<2	69
SF022S	300	200	N	20	N	100	N	<.1	.12	<5	2	.2	<2	87
SF023J	300	200	N	30	N	150	N	<.1	.02	<5	<2	<.1	<2	86
SF024S	300	300	N	20	N	100	N	<.1	.02	<5	2	<.1	<2	74
SF025J	300	200	N	20	N	100	N	<.1	.02	<5	2	.1	<2	60
SF026S	300	200	N	30	N	100	N	<.1	<.02	<5	<2	<.1	<2	85
SF027J	300	500	N	30	N	100	N	<.1	.07	<5	2	<.1	<2	85
SF028S	200	200	N	20	N	100	N	<.1	<.02	<5	<2	.2	<2	54
SF029HS	500	150	N	30	N	70	N	<.1	.02	N	N	N	N	70
SH001JS	300	100	N	30	<200	100	N	<.1	3.20	<5	<2	<.1	<2	39
SH002SS	500	700	N	15	<200	100	N	<.1	1.00	<5	2	<.1	<2	120
SH003JS	300	100	N	20	<200	100	N	<.1	.43	<5	<2	<.1	<2	72
SH004SS	300	200	N	20	<200	100	N	<.1	4.60	<5	<2	<.1	<2	85
SH005JS	500	100	N	30	<200	100	N	<.1	.12	<5	<2	.2	<2	49
SH006SS	500	300	N	20	200	100	N	<.1	.43	<5	6	.3	<2	160
SH007JS	500	200	N	20	<200	100	N	<.1	.14	<5	<2	.1	<2	58
SH008SS	500	200	N	20	<200	100	N	<.1	.06	<5	<2	.2	<2	110
SH009JS	500	200	N	20	<200	100	N	<.1	.95	<5	<2	.1	<2	68
SH010SS	500	700	N	15	300	100	N	<.1	.02	<5	<2	.7	<2	190
SH011JS	500	200	N	20	<200	100	N	<.1	.27	<5	<2	.1	<2	51
SH012SS	500	300	N	15	200	100	N	<.1	.08	<5	3	.3	<2	120
SH013JS	300	200	N	20	<200	100	N	<.1	.03	<5	<2	.1	<2	77

Table 4B. Results of ICP and AA analyses of stream-sediment samples from the Sand Hollow Wilderness Study Area, Crook County, Oregon.

Sample	As-ppm icp	Bi-ppm icp	Cd-ppm icp	Sb-ppm icp	Zn-ppm icp	Hg-ppm aa
SH021S	<5	<2	.8	<2	83	.03
SH023S	<5	<2	.4	<2	66	.03
SH024S	6	<2	1.2	<2	120	.03
SH026S	<5	<2	1.2	<2	130	.02
SH027S	<5	<2	.3	<2	51	<.02
SH028S	<5	<2	.7	<2	100	<.02
SH029S	<5	<2	.6	<2	86	<.02
SH030S	<5	<2	.9	<2	130	<.02
SH031S	<5	<2	.7	<2	95	.02
SH032S	<5	<2	.3	<2	55	.02

Table 5. Results of analyses of heavy-mineral-concentrate samples from the South Fork and Sand Hollow Wilderness Study Areas, Crook County, Oregon.

[N, not detected; <, detected but below the limit of determination shown; >, determined to be greater than the value shown.]

Sample	Latitude	Longitude	Fe-pct. s	Mg-pct. s	Ca-pct. s	Ti-pct. s	Mn-ppm s	Ag-ppm s	As-ppm s	Au-ppm s
SF001JC3	43 57 43	120 4 0	1.0	.50	10	.30	200	N	N	N
SF002SC3	43 56 51	120 3 17	1.0	.50	10	.30	200	N	N	N
SF003JC3	43 57 45	120 3 54	.7	.20	10	.20	200	N	N	N
SF004SC3	43 56 55	120 3 7	1.0	.70	10	.50	200	N	N	N
SF005JC3	43 57 20	120 3 30	1.0	.30	10	.50	200	N	N	N
SF006SC3	43 57 5	120 3 26	.5	.20	7	.10	200	N	N	N
SF007JC3	43 57 56	120 2 54	.7	.30	10	.20	200	N	N	N
SF009JC3	43 58 16	120 2 27	1.0	1.00	10	.20	200	N	N	N
SF010SC3	44 0 26	120 4 48	1.5	1.50	15	.70	500	N	N	N
SF011JC3	43 58 23	120 2 30	.7	.30	7	.15	200	N	N	N
SF013JC3	44 2 2	120 3 17	.5	.30	7	.15	200	N	N	N
SF015JC3	44 1 57	120 1 34	.7	.70	7	.15	150	N	N	N
SF016SC3	44 2 16	120 1 53	.7	.50	10	.15	200	N	N	N
SF018SC3	43 59 13	120 2 42	.7	.20	7	.20	200	N	N	N
SF019SC3	44 1 22	120 2 32	.7	.30	7	.10	150	N	N	N
SF020SC3	43 59 4	120 1 57	1.5	2.00	10	1.00	700	N	N	N
SF021JC3	43 59 48	120 1 20	1.0	1.50	10	.70	300	N	N	N
SF022SC3	43 56 13	120 1 58	1.0	.70	10	.20	200	N	N	N
SF023JC3	43 59 37	120 2 3	1.0	.50	7	.30	300	N	N	N
SF024SC3	43 55 38	120 2 50	1.0	.70	10	.15	150	N	N	N
SF025JC3	43 54 30	120 2 56	1.0	1.00	7	.30	200	N	N	N
SF026SC3	43 54 8	120 4 25	.7	.50	10	.15	200	N	N	N
SF027JC3	43 55 38	120 5 3	1.0	.50	10	.20	200	N	N	N
SF028SC3	43 54 13	120 4 32	1.0	1.00	10	.30	200	N	N	N
SF029HC3	44 1 30	120 0 27	.5	.20	10	.20	200	N	N	N
SH001JC	43 59 30	120 8 49	1.0	.70	7	.50	500	N	N	N
SH002SC	43 57 13	120 6 12	.5	.20	7	.10	150	N	N	N
SH003JC	43 59 11	120 8 53	1.0	.70	7	.30	200	N	N	N
SH004SC	43 57 5	120 7 27	.7	.15	7	.10	150	N	N	N
SH005JC	43 57 28	120 9 13	.5	.20	7	.10	200	N	N	N
SH006SC	43 57 9	120 7 34	.5	.15	7	.10	150	N	N	N
SH007JC	43 59 56	120 8 23	.5	.30	7	.15	150	N	N	N
SH008SC	43 56 48	120 7 3	.7	.10	7	.10	100	N	N	N
SH009JC	44 0 17	120 7 2	.7	.20	7	.15	200	N	N	N
SH010SC	43 57 58	120 4 54	.5	.15	7	.10	150	N	N	N
SH011JC	44 0 12	120 6 17	.7	.20	7	.15	200	N	N	N
SH012SC	43 59 36	120 5 16	.7	.20	7	.15	200	N	N	N
SH013JC	43 56 18	120 6 22	.7	.20	7	.10	150	N	N	N

Table 5. Results of analyses of heavy-mineral-concentrate samples from the South Fork and Sand Hollow Wilderness Study Areas, Crook County, Oregon.--Continued

Sample	B-ppm s	Ba-ppm s	Be-ppm s	Bi-ppm s	Cd-ppm s	Co-ppm s	Cr-ppm s	Cu-ppm s	La-ppm s	Mo-ppm s	Nb-ppm s
SF001JC3	50	500	<2	N	N	N	50	10	N	N	N
SF002SC3	50	500	<2	N	N	N	50	10	<50	N	N
SF003JC3	30	500	<2	N	N	N	30	10	N	N	N
SF004SC3	100	500	<2	N	N	N	70	10	70	N	N
SF005JC3	50	500	<2	N	N	N	20	10	<50	N	N
SF006SC3	50	500	<2	N	N	N	30	<10	N	N	N
SF007JC3	30	500	<2	N	N	N	20	10	N	N	N
SF009JC3	50	500	<2	N	N	N	100	10	<50	N	N
SF010SC3	50	200	<2	N	N	10	150	15	100	N	N
SF011JC3	50	300	<2	N	N	N	20	<10	N	N	N
SF013JC3	30	300	<2	N	N	N	50	10	N	N	N
SF015JC3	30	200	<2	N	N	N	100	10	<50	N	N
SF016SC3	30	500	<2	N	N	N	150	15	N	N	N
SF018SC3	20	500	<2	N	N	N	20	10	N	N	N
SF019SC3	20	500	<2	N	N	N	50	<10	N	N	N
SF020SC3	150	500	<2	N	N	10	70	15	150	N	N
SF021JC3	<20	500	<2	N	N	10	100	15	70	N	N
SF022SC3	20	500	<2	N	N	N	100	10	50	N	N
SF023JC3	30	500	<2	N	N	N	30	10	50	N	N
SF024SC3	20	500	<2	N	N	N	70	10	N	N	N
SF025JC3	30	500	<2	N	N	N	150	<10	100	N	N
SF026SC3	<20	500	<2	N	N	N	20	10	50	N	N
SF027JC3	30	500	<2	N	N	N	50	10	<50	N	N
SF028SC3	20	500	<2	N	N	N	30	15	50	N	N
SF029HC3	<20	500	<2	N	N	N	20	<10	100	N	N
SH001JC	70	1,500	<2	N	N	N	100	10	150	N	N
SH002SC	50	300	<2	N	N	N	20	<10	N	N	N
SH003JC	50	500	<2	N	N	N	100	10	N	N	N
SH004SC	50	300	<2	N	N	N	20	<10	N	N	N
SH005JC	50	300	<2	N	N	N	<20	<10	70	N	N
SH006SC	30	300	<2	N	N	N	<20	10	N	N	N
SH007JC	50	300	<2	N	N	N	<20	10	N	N	N
SH008SC	50	300	<2	N	N	N	<20	<10	N	N	N
SH009JC	100	500	<2	N	N	N	<20	10	<50	N	N
SH010SC	20	300	<2	N	N	N	<20	<10	N	N	N
SH011JC	20	300	<2	N	N	N	50	10	50	N	N
SH012SC	30	300	<2	N	N	N	<20	<10	<50	N	N
SH013JC	30	300	<2	N	N	N	<20	<10	N	N	N

Table 5. Results of analyses of heavy-mineral-concentrate samples from the South Fork and Sand Hollow Wilderness Study Areas, Crook County, Oregon.--Continued

Sample	Ni-ppm s	Pb-ppm s	Sb-ppm s	Sc-ppm s	Sn-ppm s	Sr-ppm s	V-ppm s	W-ppm s	Y-ppm s	Zn-ppm s	Zr-ppm s	Th-ppm s
SF001JC3	<10	N	N	<10	N	2,000	30	<100	50	N	2,000	N
SF002SC3	<10	N	N	<10	N	2,000	30	<100	70	N	>2,000	N
SF003JC3	<10	N	N	<10	N	2,000	30	100	50	N	2,000	N
SF004SC3	<10	N	N	<10	N	2,000	50	<100	100	N	>2,000	N
SF005JC3	<10	N	N	<10	N	2,000	50	<100	70	N	>2,000	N
SF006SC3	<10	N	N	<10	N	2,000	20	100	30	N	2,000	N
SF007JC3	<10	N	N	<10	N	2,000	30	<100	50	N	>2,000	N
SF009JC3	<10	N	N	<10	N	1,500	50	N	50	N	>2,000	N
SF010SC3	<10	N	N	<10	N	1,500	100	500	100	N	>2,000	N
SF011JC3	<10	N	N	<10	100	1,500	30	<100	30	N	2,000	N
SF013JC3	<10	N	N	<10	200	1,500	30	<100	50	N	>2,000	N
SF015JC3	<10	N	N	<10	N	1,500	30	N	20	N	1,500	N
SF016SC3	<10	N	N	<10	N	2,000	50	<100	30	N	2,000	N
SF018SC3	<10	N	N	<10	N	2,000	50	<100	70	N	>2,000	N
SF019SC3	<10	N	N	<10	N	1,500	50	<100	<20	N	1,000	N
SF020SC3	<10	N	N	<10	N	1,500	100	<100	100	N	>2,000	N
SF021JC3	<10	N	N	<10	N	1,500	70	<100	100	N	>2,000	N
SF022SC3	<10	N	N	<10	N	2,000	50	<100	70	N	>2,000	N
SF023JC3	<10	N	N	<10	N	1,500	70	<100	70	N	>2,000	N
SF024SC3	<10	N	N	<10	N	1,500	50	<100	30	N	2,000	N
SF025JC3	<10	N	N	<10	N	1,500	70	<100	70	N	>2,000	N
SF026SC3	<10	N	N	<10	N	1,500	30	<100	70	N	>2,000	N
SF027JC3	<10	N	N	<10	N	2,000	50	<100	100	N	>2,000	N
SF028SC3	<10	N	N	<10	70	2,000	50	<100	100	N	>2,000	N
SF029HC3	<10	N	N	<10	N	1,000	20	N	100	N	>2,000	N
SH001JC	20	N	N	<10	N	1,500	50	N	200	N	>2,000	N
SH002SC	<10	N	N	<10	N	2,000	20	N	30	N	1,500	N
SH003JC	20	N	N	<10	N	2,000	50	N	300	N	>2,000	N
SH004SC	<10	N	N	<10	N	2,000	20	N	20	N	2,000	N
SH005JC	<10	N	N	<10	N	2,000	30	N	200	N	>2,000	N
SH006SC	<10	N	N	<10	N	2,000	30	N	30	N	>2,000	N
SH007JC	<10	N	N	<10	N	1,000	50	N	50	N	>2,000	N
SH008SC	<10	N	N	<10	N	2,000	20	N	20	N	1,000	N
SH009JC	<10	N	N	<10	N	2,000	50	N	150	N	>2,000	N
SH010SC	<10	N	N	<10	N	2,000	30	N	70	N	>2,000	N
SH011JC	<10	N	N	<10	N	2,000	30	<100	100	N	>2,000	N
SH012SC	<10	N	N	<10	N	2,000	30	N	100	N	>2,000	N
SH013JC	<10	N	N	<10	N	2,000	20	N	30	N	2,000	N

Table 6A. Results of analyse of rock samples from the South Fork and Sand Hollow Wilderness Study Area, Crook County, Oregon.

Sample	Latitude	Longitude	Fe-pct. s	Mg-pct. s	Ca-pct. s	Ti-pct. s	Mn-ppm s	Ag-ppm s	As-ppm s	Au-ppm s	B-ppm s	Ba-ppm s
SF014SR1	44 1 23	120 3 29	7.0	2.0	7.00	.70	700	N	N	N	20	500
SF014SR2	44 1 23	120 3 29	.2	.1	.07	.05	100	N	N	N	200	70
SH007JR	43 59 56	120 8 23	10.0	2.0	7.00	>1.00	1,500	N	N	N	10	700
SH009JR	44 0 17	120 7 2	5.0	1.5	1.00	1.00	2,000	N	N	N	50	500

Sample	Be-ppm s	Bi-ppm s	Cd-ppm s	Co-ppm s	Cr-ppm s	Cu-ppm s	La-ppm s	Mo-ppm s	Nb-ppm s	Ni-ppm s	Pb-ppm s	Sb-ppm s	Sc-ppm s
SF014SR1	1	N	N	20	300	30	30	N	N	50	N	N	20
SF014SR2	1	N	N	<5	15	7	N	N	N	7	N	N	<5
SH007JR	<1	N	N	30	15	70	30	N	<20	10	15	N	30
SH009JR	1	N	N	20	100	100	30	N	<20	30	N	N	20

Sample	Sn-ppm s	Sr-ppm s	V-ppm s	W-ppm s	Y-ppm s	Zn-ppm s	Zr-ppm s	Th-ppm s	As-ppm aa	Bi-ppm aa	Cd-ppm aa	Sb-ppm aa	Zn-ppm aa
SF014SR1	N	700	200	N	15	<200	100	N	<5	<2	.5	<2	40
SF014SR2	N	<100	20	N	N	N	10	N	6	<2	<.1	<2	3
SH007JR	N	500	200	N	30	<200	150	N	<5	<2	1.1	<2	80
SH009JR	N	300	150	N	20	<200	150	N	<5	<2	.8	<2	51

Table 6B. Results of ICP and AA analyses of rock samples from the Sand Hollow Wilderness Study Area, Crook County, Oregon.

Sample	As-ppm icp	Bi-ppm icp	Cd-ppm icp	Sb-ppm icp	Zn-ppm icp	Hg-ppm aa
SH021R	<5	<2	.2	2	46	.03
SH022R	<5	<2	<.1	<2	14	<.02
SH023R	<5	<2	<.1	<2	14	<.02
SH024R	<5	<2	<.1	<2	21	<.02
SH025R1	<5	<2	<.1	<2	13	<.02
SH026R	<5	<2	<.1	<2	74	<.02
SH028R	<5	<2	.2	<2	91	<.02
SH030R	<5	<2	<.1	<2	8	<.02
SH031R	<5	<2	<.1	<2	72	<.02
SH032R	8	<2	.2	<2	4	<.02