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Analysis of soil samples from the Fernley Area--Churchill, Lyon, and Washoe Counties, Nevada

by

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INTRODUCTION

The data included in this report represent total chemical analyses of soil samples collected within and near the Fernley Wildlife Management Area in 1987 by R.R. Tidball (USGS). The area is managed by the State of Nevada and is located in Lyon County about 6 miles east of Fernley, Nevada.

FIELD SAMPLING

Soil samples were collected according to a stratified random design in which one site was selected within each of 25 quadrangles that were 5 km on a side. The study area is centered in the Fernley Wildlife Management Area and includes a limited surrounding area on the valley floor. Each sample is a vertical composite over the depth of 0-12 inches (0-30 cm).

SAMPLE PREPARATION

Samples were initially air dried in the field and further dried with forced air at ambient temperature then crushed and sieved through a 2-mm stainless steel screen. The material less than 2 mm was thoroughly mixed and split using a Jones splitter. Chemical analysis was performed on a subsample that was ground in a ceramic shatter box to minus 100 mesh.

ANALYTICAL METHODS

Samples were analyzed simultaneously for 37 elements using induction-coupled plasma-emission spectroscopy (ICP) and for 9 additional elements by other methods. The following elements were analyzed for by ICP but were not detected at the limits shown: Ag (2), Au (8), Bi (10), Cd (1), Eu (2), Ho (4), Sn (10), and Ta (40). Each sample was dissolved using a low-temperature multi-acid digestion with concentrated hydrochloric, hydrofluoric, nitric and perchloric acids (Crock and others, 1983). Lower limits of determination are shown in Table 1. The relative standard deviation for replicate determinations of most elements is about 5 percent.

Water-extractable boron was determined by ICP (Baedecker, 1987). Five-gram samples were mixed with 10 grams of deionized water in capped polypropylene tubes. The tubes were immersed in a boiling-water bath for 1 hour, cooled slightly, and centrifuged. The clear solution was aspirated directly into a Jarrell-Ash model 1160 plasma spectrometer and boron emission was measured at 2497 A. The relative standard deviation for the method is about 7 percent.

Cold vapor atomic absorption spectroscopy method was used to determine mercury (Kennedy and Crock, 1987). A 0.1 g sample was digested with nitric acid and 25 percent (weight/volume) sodium dichromate solution. Mercury vapor produced in a continuous flow system was swept into the light path of the spectrometer. The relative standard deviation of the method is about 10 percent.

Arsenic, selenium, and antimony were determined by continuous-flow hydride generation followed by atomic absorption (Briggs and Crock, 1986; Crock and Lichte, 1982). One gram of sample was digested with nitric, perchloric, sulfuric, and hydrofluoric acids. After digestion the sample was diluted to 100 ml with 10 percent hydrochloric acid and allowed to sit overnight to ensure the conversion of Se-VI to Se-IV. The sample was reacted with sodium borohydride in a continuous flow system to generate hydride gas which was passed in an argon stream into the light path of the atomic absorption spectrometer. The relative standard deviation for these elements is about 10 percent.

Total carbon and total sulfur were determined by combustion infrared absorption spectroscopy (Baedecker, 1987). Total carbon was determined using a Leco model CR12 analyzer in which samples (0.5-1.0 g) were combusted a 1370°C in an oxygen atmosphere. Total sulfur was determined using a Leco model SC132 total sulfur analyzer. Samples of 0.25 g were mixed with vanadium pentoxide and combusted at 1400 to 1600°C in an oxygen atmosphere. The gases generated during the heating process are swept in infrared detectors. The relative standard deviation for carbon is 10 percent and for sulfur 5-10 percent.

Uranium and thorium were determined on 8- to 10-gram splits of sample powder by the delayed-neutron technique (McKown and Millard, 1987). The precision and accuracy for individual determinations are dependent on counting statistics. These in turn are dependent on total weight of the sample aliquot, and the concentrations and relative proportions of uranium and thorium. Uranium contents are generally accurate to within plus or minus 5 percent of the amount reported (2 sigma) for concentrations greater than 1 ppm. Thorium contents greater than 10 ppm are generally accurate to within plus or minus 10 percent of the amount reported (2 sigma) but are less accurate for samples with Th/U ratios less than 3 or thorium contents less than 10 ppm.

RESULTS

Sample site locations are shown in Figure 1. Each site is annotated with the last 3 digits of the sample number. The elements analyzed, the analytical methods, and the lower limits of determination are given in Table 1. Information on sample location and elemental composition of the samples is shown in Table 2.

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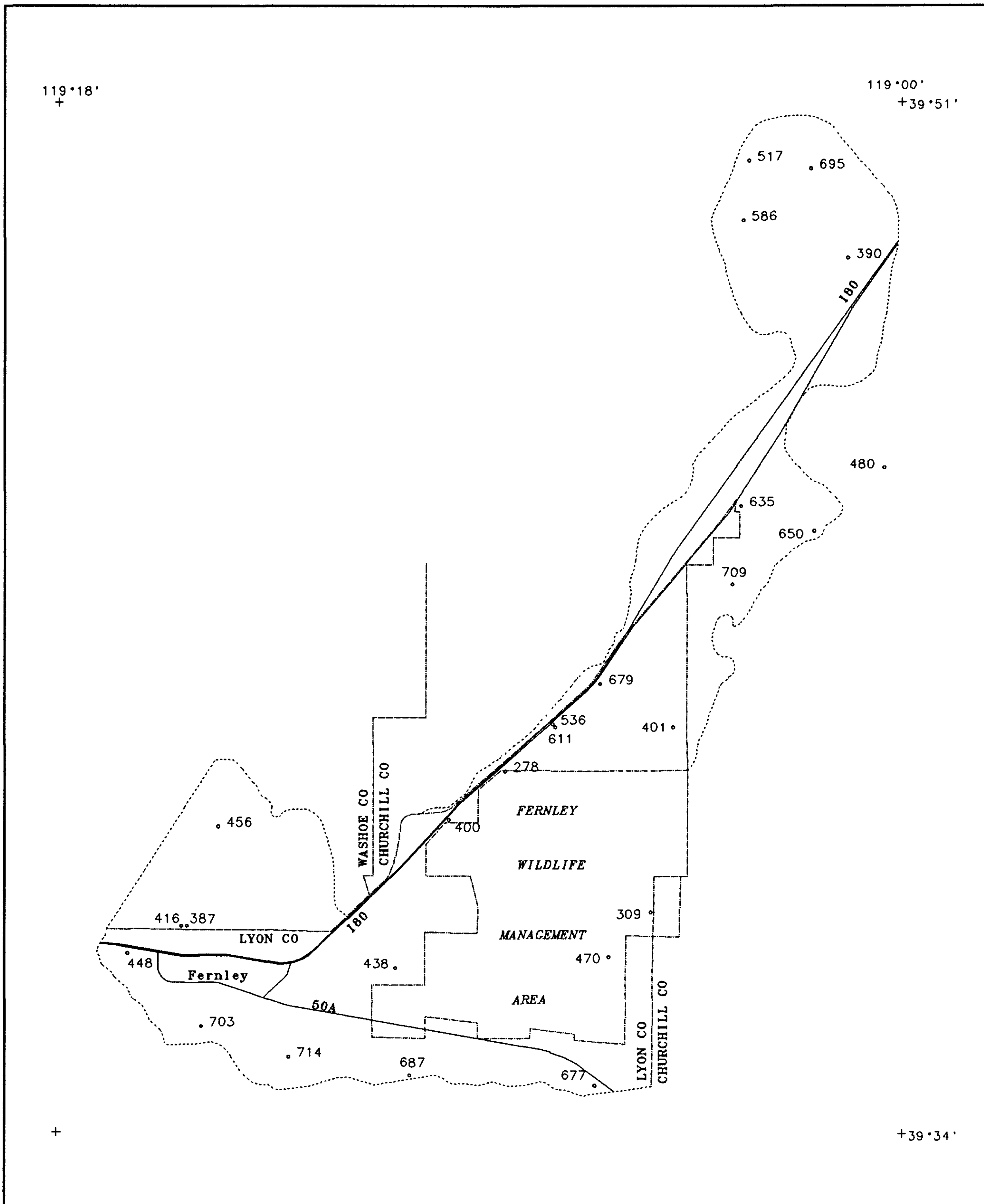

Figure 1.--Map of Fernley Wildlife Management Area and surrounding area. Approximate boundary of valley and study area shown by dotted line. Soil sampling sites marked with an open circle and annotated with last 3 digits of laboratory number.

Table 1.--Elements analyzed, methods, and lower limits of determination. [Parts per million unless otherwise noted. Analytical methods: CV, cold vapor, atomic absorption; I, inductively coupled plasma emission spectroscopy; IR, combustion infrared absorption spectrophotometry. HG, hydride generation and atomic absorption; NA, delayed neutron activation; XW, hot-water extraction.]

Elements & Methods	Lower limit
Aluminum (Al-I), %	.05%
Antimony (Sb-HG)	.02
Arsenic (As-HG)	.1
Barium (Ba-I)	1
Beryllium (Be-I)	1
Boron (B-XW)	.4
Calcium (Ca-I), %	.05%
Carbon (C-IR), %	.01%
Cerium (Ce-I)	4
Cobalt (Co-I)	1
Chromium (Cr-I)	1
Copper (Cu-I)	1
Gallium (Ga-I)	4
Iron (Fe-I), %	.05%
Lanthanum (La-I)	2
Lead (Pb-I)	4
Lithium (Li-I)	2
Magnesium (Mg-I), %	.005%
Manganese (Mn-I)	4
Mercury (Hg-CV)	.02
Molybdenum (Mo-I)	2
Neodymium (Nd-I)	4
Niobium (Nb-I)	4
Nickel (Ni-I)	2
Phosphorus (P-I), %	.005%
Potassium (K-I), %	.05%
Scandium (Sc-I)	2
Selenium (Se-HG)	.1
Sodium (Na-I), %	.005%
Strontium (Sr-I)	2
Sulfur (S-IR)	.01
Thorium (Th-NA)	1
Titanium (Ti-I), %	.005%
Vanadium (V-I)	2
Uranium (U-NA)	.1
Ytterbium (Yb-I)	1
Yttrium (Y-I)	2
Zinc (Zn-I)	2

Table 2.--Total chemical analysis of soil samples 0-12 inches (0-30 cm) depth from Fernley Wildlife Management Area, Nevada.

[DMS, degrees, minutes, and seconds. H, matrix interference; L, lower limit of determination. Analytical methods: CV, cold vapor, atomic absorption; HG, hydride generation and atomic absorption; I, induction-coupled plasma-emission spectroscopy; IR, combustion infrared absorption spectroscopy; NA, neutron activation; XW, hot-water extraction.]

Lab No.	Lat.DMS	Long.DMS	Al % I	As ppm HG	B ppm XW	Ba ppm I	Be ppm I
D286278	393957	1190827	7.8	50	96	250	1
D286309	393738	1190522	8.6	26	0H	720	1
D286387	393724	1191516	8.2	6.3	1.1	880	1
D286390	394826	1190109	7.6	66	46	260	1
D286400	393909	1190938	8.8	21	25	910	1
D286401	394041	1190451	7.6	19	0H	760	1
D286416	393724	1191521	8.5	5.5	1	890	1
D286438	393643	1191048	8.1	6.5	1.6	860	1
D286448	393657	1191630	8.1	7.2	.7	860	1
D286456	393902	1191433	8.3	4.7	.6	880	1
D286470	393654	1190613	8.7	20	110	790	1
D286480	394458	1190020	7.9	12	1	970	1
D286517	395003	1190315	8.5	15	.7	900	1
D286536	394044	1190725	8.9	32	91	910	1
D286586	394904	1190323	8.6	13	15	980	2
D286611	394041	1190723	9.0	32	79	860	1
D286635	394420	1190326	8.0	20	45	920	1
D286650	394355	1190150	8.4	20	100	930	1
D286677	393447	1190633	8.4	11	1	820	1
D286679	394124	1190625	7.3	33	43	680	1
D286687	393457	1191029	9.0	8.8	1.2	740	1
D286695	394955	1190156	8.4	10	1.2	850	1
D286703	393545	1191458	9.2	13	1.2	870	1
D286709	394303	1190335	8.0	12	72	1200	1
D286714	393515	1191306	9.0	13	7.5	890	1

Lab No.	Total C % IR	Ca % I	Ce ppm I	Co ppm I	Cr ppm I	Cu ppm I
D286278	1.12	6.2	37	15	32	39
D286309	.08	2.4	44	17	31	42
D286387	.22	3.5	34	14	35	16
D286390	.67	6.1	42	13	37	31
D286400	.46	2.9	47	17	30	48
D286401	.12	2.8	35	14	28	31
D286416	.37	3.9	46	14	38	17
D286438	.01	3.3	35	15	31	19
D286448	.01L	3.1	34	15	32	20
D286456	.02	3.4	38	16	44	17
D286470	.22	3.1	49	17	34	45
D286480	.25	4.0	39	15	37	15
D286517	.32	3.4	39	13	39	18
D286536	.74	4.1	46	19	36	45
D286586	.76	4.3	56	17	50	33
D286611	.22	2.7	49	19	34	52
D286635	.66	4.3	39	15	40	24
D286650	.16	4.0	34	13	33	19
D286677	.91	5.6	36	20	58	26
D286679	2.58	5.5	41	17	37	53
D286687	1.22	4.2	33	20	67	27
D286695	.08	3.0	40	14	46	24
D286703	.33	4.2	42	18	46	24
D286709	.46	4.4	38	16	34	32
D286714	.77	3.4	41	17	39	30

Lab No.	Fe % I	Ga ppm I	Hg ppm CV	K % I	La ppm I	Li ppm I
D286278	3.7	17	.04	1.8	21	58
D286309	4.0	18	.02L	1.7	27	53
D286387	3.3	17	.02L	2.0	19	17
D286390	3.4	17	.06	1.6	22	73
D286400	4.3	21	.02	1.9	25	58
D286401	3.4	17	.02L	1.7	20	44
D286416	3.6	18	.02L	2.0	24	18
D286438	3.2	18	.02L	1.9	19	17
D286448	3.3	19	.02L	2.0	18	16
D286456	3.7	19	.02	1.9	22	15
D286470	4.0	20	.02	1.6	29	55
D286480	3.6	16	.02L	1.9	23	33
D286517	3.1	16	.02L	2.0	23	27
D286536	4.5	20	.02L	2.1	28	77
D286586	4.1	19	.08	1.8	30	46
D286611	4.6	21	.02	2.0	26	79
D286635	3.4	19	.02	2.0	22	140
D286650	3.0	17	.02L	1.8	20	90
D286677	4.9	20	.02L	1.4	21	30
D286679	3.8	18	.02	1.8	24	110
D286687	4.7	20	.06	1.1	20	28
D286695	3.4	18	.02L	1.8	23	31
D286703	3.9	19	.02	1.7	23	38
D286709	3.7	17	.02	1.9	22	98
D286714	3.7	18	.06	1.8	23	30

Lab No.	Mg % I	Mn ppm I	Mo ppm I	Na % I	Nb ppm I	Nd ppm I
D286278	1.8	820	20	3.9	6	20
D286309	1.9	790	3	3.5	6	23
D286387	1.2	670	2	2.3	5	18
D286390	1.6	710	4	2.2	6	21
D286400	2.0	1200	2	2.8	8	24
D286401	1.4	590	2	7.7	10	19
D286416	1.4	720	2	2.5	5	22
D286438	1.3	670	2	2.4	5	18
D286448	1.2	630	2	2.4	6	18
D286456	1.5	700	2	2.5	5	18
D286470	1.7	980	7	4.7	8	24
D286480	1.4	730	2	2.3	7	21
D286517	1.2	680	2	2.2	8	22
D286536	2.2	1100	2	2.8	8	24
D286586	1.6	890	3	2.3	9	31
D286611	2.2	860	2	3.0	8	27
D286635	1.7	700	2	3.2	7	20
D286650	1.6	600	2	3.6	7	17
D286677	1.9	910	2	2.2	7	20
D286679	2.1	1200	5	3.2	7	21
D286687	2.0	980	2	2.2	5	20
D286695	1.3	730	2	2.2	7	23
D286703	1.3	850	2	2.2	8	22
D286709	1.5	710	2	3.5	6	20
D286714	1.4	790	2	2.4	7	21

Lab No.	Ni ppm I	P % I	Pb ppm I	Total S % IR	Sb ppm HG	Sc ppm I
D286278	17	0.08	11	1.62	1.7	12
D286309	20	0.09	14	.15	1.2	13
D286387	16	0.07	14	.02	0.6	11
D286390	17	0.10	12	1.70	1.7	11
D286400	22	0.13	16	.16	0.8	14
D286401	15	0.07	13	.41	0.8	11
D286416	17	0.07	15	.03	0.4	11
D286438	15	0.07	12	.02	0.6	11
D286448	15	0.07	13	.02	0.7	11
D286456	19	0.08	15	.03	0.5	12
D286470	22	0.10	14	.43	0.8	13
D286480	17	0.11	12	.01	0.6	11
D286517	15	0.10	14	.02	1.1	11
D286536	20	0.13	13	.08	1.1	14
D286586	24	0.15	17	.02	0.6	14
D286611	21	0.11	20	.05	0.7	15
D286635	18	0.11	13	.09	0.7	11
D286650	14	0.08	12	.04	0.6	11
D286677	20	0.09	13	.03	1.0	15
D286679	24	0.12	14	.20	1.8	13
D286687	22	0.09	12	.03	0.9	18
D286695	20	0.08	14	.01	1.4	12
D286703	22	0.09	14	.01L	2.7	12
D286709	17	0.10	15	.04	0.9	12
D286714	20	0.11	14	.07	1.2	12

Lab No.	Se ppm HG	Sr ppm I	Th ppm NA	Ti % I	U ppm NA	V ppm I
D286278	1.2	960	14.1	0.34	3.17	110
D286309	.5	460	15.1	0.38	7.19	110
D286387	.2	550	18.1	0.32	5.63	100
D286390	.6	980	12.0	0.37	3.74	230
D286400	.3	470	6.50	0.40	2.17	110
D286401	.4	530	11.2	0.32	3.35	97
D286416	.2	610	14.2	0.35	3.23	120
D286438	.1L	530	6.17	0.32	1.80	100
D286448	.1L	540	13.5	0.34	3.65	110
D286456	.1L	540	7.15	0.34	2.30	120
D286470	.4	510	12.9	0.40	4.78	110
D286480	.2	600	10.8	0.40	4.88	130
D286517	.3	540	8.3	0.37	2.16	100
D286536	.5	520	16.1	0.45	6.29	140
D286586	.3	560	10.1	0.47	2.89	100
D286611	.3	450	16.8	0.45	13.4	130
D286635	.4	700	10.2	0.36	2.55	99
D286650	.2	740	7.38	0.31	1.78	92
D286677	.3	670	9.50	0.48	2.57	170
D286679	1.1	500	13.0	0.37	9.21	130
D286687	.1L	640	7.32	0.46	2.54	160
D286695	.1L	520	9.08	0.40	2.69	98
D286703	.3	720	13.5	0.46	3.74	120
D286709	.2	610	17.9	0.38	5.77	110
D286714	.3	570	10.4	0.39	2.25	110

Lab No.	Y ppm I	Yb ppm I	Zn ppm I
D286278	13	2	72
D286309	14	2	80
D286387	12	1	59
D286390	15	2	66
D286400	17	2	93
D286401	12	1	67
D286416	13	2	60
D286438	13	1	58
D286448	12	1	58
D286456	12	1	66
D286470	15	2	83
D286480	16	2	62
D286517	15	2	53
D286536	16	2	91
D286586	23	3	78
D286611	17	2	98
D286635	15	2	65
D286650	13	1	50
D286677	15	2	86
D286679	13	2	85
D286687	15	2	82
D286695	17	2	64
D286703	16	2	71
D286709	14	2	71
D286714	15	2	71