UNITED STATES DEPARTMENT OF THE INTERIOR

GEOLOGICAL SURVEY

LATERAL AND DEPTH VARIABILITY IN CHEMICAL COMPOSITION OF SOIL AT THE KENDRICK RECLAMATION PROJECT AREA, WYOMING

by

R.C. Severson*, J.G. Crock*, and J.A. Erdman*

Open-File Report 89-470

*U.S. Geological Survey, DFC, Box 25046, MS 973, Denver, CO 80225

1989

CONTENTS

ILLUSTRATIONS

TABLES

APPENDIX TABLE

INTRODUCTION

A study of the chemical composition and variability of soils was undertaken to provide information on the distribution of elements within the Kendrick Reclamation Project Area (KRPA) irrigation development. Irrigated agricultural soils of the KRPA are developed on sediments derived from the Cretaceous Cody shale and Quaternary alluvium. The Cody shale is mainly fine-grained and of marine origin, and the Quaternary alluvium is locally derived from the Cody shale. Prior studies in this area (Peterson, Jones, and Morton, 1988; Severson, Wilson, and McNeal, 1987) have suggested elevated levels of some elements in water, wildlife, and bed sediments and a possible relationship to return flow from irrigated agricultural lands.

Our present concern is to compile maps of element distributions in soils from data already collected. The purpose of this study was to determine if, with a given number of samples, those maps are expected to be truly representative of the distribution of elements in the soils of the area. Examples are given of elements that can be mapped, of elements that are best described by a mean value, and of elements for which the procedural error is too large to prepare maps or provide reliable mean values.

The present study is similar in design and methods to a geochemical survey conducted in the San Joaquin Valley of California (Severson, Tidball, and Wilson, 1987). Portions of the background information describing methods from that report are incorporated into this report.

METHODS

Field Sampling

During June 1988, soil samples were collected from irrigated agricultural land within the KRPA (Fig. 1). The sampling sites were based on the distribution of irrigated fields of 40 acres or more per section (1 mi^2). Irrigated fields in the KRPA are not contiguous, but occur in parcels ranging in size from a single section to many adjacent sections. Consequently, samples were collected on an irregular 1-mile grid at 109 irrigated fields, one field per square mile (Fig. 2); however, at 10 sites two profiles about 100 meters apart were sampled resulting in a total of 119 samples.

A subset of 96 additional samples was collected according to an analysis-of-variance design (ANOVA) within each of eight randomly selected locations as shown in Fig. 2. At each of the eight grid locations, an adjacent section was selected for additional sampling. Within each of the two sections at each of the eight locations, two soil profiles were sampled at distances of about 100 meters apart. Samples of the A, B, and C horizons, where present, were collected and analyzed. Where distinct horizons were not present in a profile, the upper 20 cm was sampled, the 20-60 cm zone was sampled, and the 60-100 cm zone was sampled.

All samples were collected by hand with a 3-1/4" (8.25 cm) diameter stainless steel bucket auger. About 2-1/4 lbs. (1 kg) of soil was collected from each of three depth zones at the analysis-of-variance sites. At the grid sampling sites, a composite sample was collected from the surface soil to a depth of 100 cm.

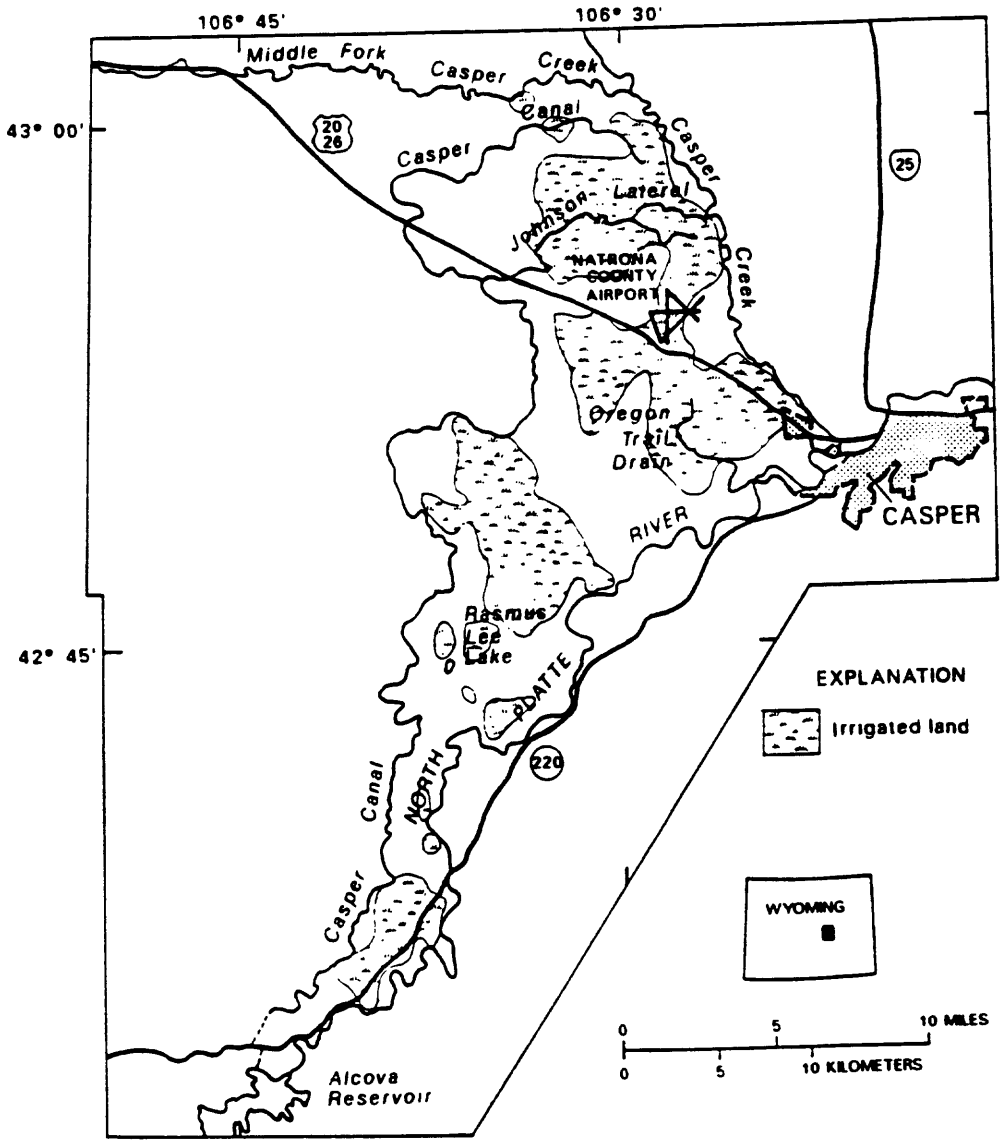

Figure 1. Index map showing the location of the Kendrick Reclamation Project Area in Wyoming.

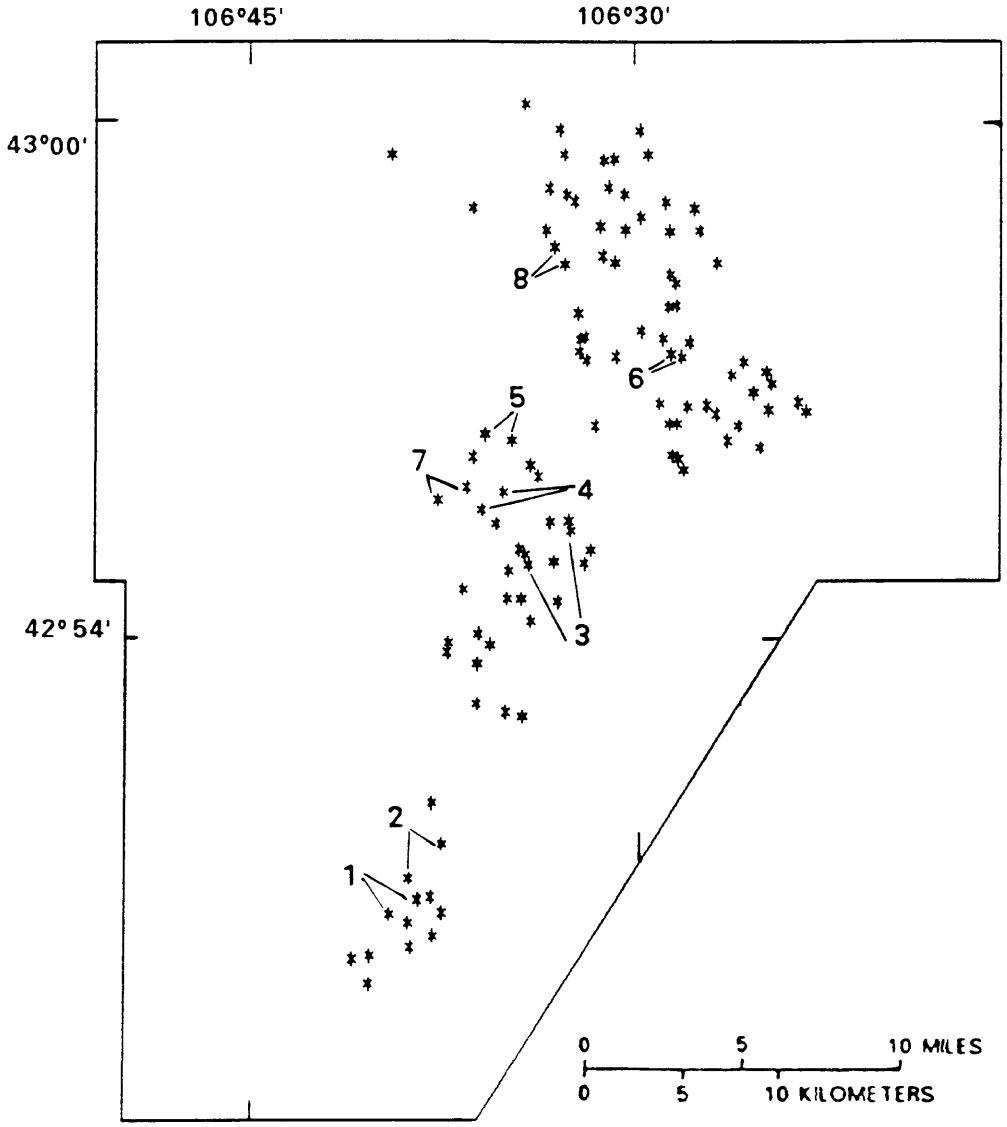

Figure 2. Map showing the grid and analysis-of-variance sampling locations.

Laboratory Methods

Soil samples were mailed to the U.S. Geological Survey laboratories in Denver for preparation and analysis. The soil samples were air dried under forced air at ambient temperatures. The dried samples were disaggregated with a mechanical mortar and pestle and the minus 10 mesh (2 mm) material sieved and saved for analyses. A split of the minus 2 mm material was ground in a ceramic plate grinder to minus 100 mesh, and this material was used for all chemical analysis. Six of the 96 analysis-of-variance samples were split into two parts and each part analyzed independently to evaluate procedural (laboratory and instrumental) errors (ANOVA splits). All samples--grid, ANOVA, and ANOVA splits--were arranged in a randomized sequence and analyzed in that sequence to convert any systematic laboratory bias to a random error.

Chemical analyses were performed by two main techniques, inductively-coupled plasma atomic emission spectroscopy (ICP-AES) and continuous-flow hydride generation atomic absorption spectroscopy (HGAAS). Additional determinations are described under the heading "**Miscellaneous determinations**".

Inductively-Coupled Plasma Atomic Emission Spectroscopy

Samples were analyzed simultaneously for 38 elements using ICP-AES. Each sample (0.200 g) was dissolved using a low-temperature digestion with concentrated hydrochloric, hydrofluoric, nitric, and perchloric acids (Crock and others, 1983). The acidic sample solution was taken to dryness and the residue was dissolved with 1 mL of aqua regia and then diluted to 10 g with deionized water. Reagent blanks, reference materials, and sample replicates were all digested by the same procedure and analyzed at the same time as the samples. The elements bismuth, cadmium, gold, holmium, silver, tantalum, tin, and uranium were below detection in all samples. The relative standard deviation (RSD) for replicate determinations of most elements was 5 percent or less.

Continuous-Flow Hydride Generation Atomic Absorption Spectroscopy

Arsenic and selenium were determined by continuous-flow hydride generation atomic absorption spectroscopy (HGAAS) (Crock and Lichte, 1982; Sanzolone and Chao, 1987). A 0.25 gram sample was digested with nitric, perchloric, and hydrofluoric acids. After digestion, the sample was diluted to 50mL with 6N HCl. Arsenic and selenium were determined independently using specifically designed continuous-flow systems. In the procedure, the sample solution was reacted with sodium borohydride in order to generate the gaseous hydrides which were swept into the heated-quartz furnace of an atomic absorption spectrometer. Arsenic and selenium were determined using an aqueous standard calibration curve. The RSD for the determination of both elements was about 10 percent.

Miscellaneous Determinations

Mercury was determined using an automated continuous-flow cold vapor atomic absorption spectroscopic method (Kennedy and Crock, 1987). A 0.100 g sample was digested with nitric acid and sodium dichromate in a closed teflon bottle and then diluted to 12 mL with deionized water. The solution was reacted with a sulfuric acid-hydroxylamine hydrochloride solution and stannous

chloride solution in a continuous-flow system. The gaseous mercury was separated in a phase separator and swept into a quartz cell of an atomic absorption spectrometer. Mercury was determined using an aqueous standard calibration curve.

Soil pH was determined by a 1:1 water extraction of the soil according to the method given in Crock and Severson (1980). A standard 20 g soil to 20 g demineralized-deionized water extraction was made and the solution pH measured using a standard pH meter calibrated with pH 7 and pH 10 buffer solutions.

Hot-water extractable boron was determined from a 1:5 hot water extract of the soil according to the method given in Crock and Severson (1980). Five grams of soil were mixed with 25 mL of demineralized water in a 50 mL polyethylene centrifuge tube. Each tube was capped and placed in boiling water for 1 hour with occasional shaking. The mixture was then centrifuged at 2,500 RPM for 10 minutes, and the resulting clear supernatant was decanted and filtered through 0.45 micrometer filter disks. The filtrate was acidified with concentrated nitric acid. The boron content was measured using ICP-AES under standard conditions.

RESULTS

Analysis-of-Variance Sampling

The ANOVA consisted of a nested plus crossed classification (Bennett and Franklin 1967). Two profiles (P) spaced 100-m apart were sampled from fields in two adjacent sections (S) in each of the eight randomly selected locations (L) (Fig. 2). The profiles were nested within sections (P(LS)), and the sections were nested within locations (S(L)). At each profile, three depth zones or horizons (H) were sampled. These three horizons are crossed with profiles (PH(LS), sections (SH(L), and locations (LH). This sampling design is summarized in the following table:

Variation between:	Symbolic nesting
Locations (n = 8)	L
Sections within locations (n = 2)	S(L)
Profiles within sections and locations (n = 2)	P(LS)
Depth zones or Horizons (n = 3)	H
Interactions;	
Location X Depth Zone	LH
Section X Depth Zone within Locations	SH(L)
Profile X Depth Zone within Locations and Sections	PH(LS)

Table 1 contains the ANOVA results of this crossed plus nested design expressed as variance components for main effects and their interactions, plus an estimate of procedural errors. This estimate was obtained separately from the six analysis-of-variance samples (ANOVA splits) that were split into two parts and analyzed independently. The estimated procedural error was subtracted from the PH(LS) term, and it exceeded the PH(LS) term for cerium, copper, mercury, lanthanum, neodymium, and thorium. For these elements, the procedural error is listed as a greater-than value, and the PH(LS) term is reduced to zero. Normally, the main effects and their interactions are tested against the error term, but in this case there is no true error term because there is no complete replication of analyses (the estimate of analytical error

is based on only partial replication). Therefore, the lowest interaction term, profile x depth zone plus the estimate of procedural error, PH(LS)+E, becomes the error term. Testing for statistical significance was done by computing ratios between variance components as follows: L/S(L), S(L)/P(LS), P(LS)/PH(LS)+E, H/PH(LS)+E, LH/PH(LS)+E, SH(L)/PH(LS)+E, and comparing the ratios to table values for an F-distribution at a confidence level of 0.05.

The PH(LS) and SH(L) interactions (Table 1) are not interpreted because statistical significance of the PH(LS) interaction could not be computed, and the SH(L) interaction is of little practical importance.

The LH interaction (Table 1) was statistically significant for pH, boron, barium, cerium, lanthanum, and strontium. A significant interaction means that, on the average, differences between depth zones (horizons) are not consistent across all sections. The data for pH is used as the example (Fig. 3). The location numbers shown in Fig. 3 correspond to the locations shown in Fig. 2. This example suggests that an individual map for each depth zone will be required to portray the distribution of each of the six statistically significant variables.

Statistically significant differences between depth zones (H) within a profile were found for pH, calcium, magnesium, and strontium (Table 1). Average values for element concentration of each depth zone are shown in Fig. 4 for these four variables. Separate maps are required to show the variable distribution patterns for each depth zone. The concentration ranges exhibited by each depth zone map would be similar to the trends with depth shown in Fig. 4 for these four variables. Most other elements show no variation between depth zones. Therefore, for most elements, a single map of element distribution prepared using the data from any one depth zone, or a composite sample of all depth zones as was collected for the gridded sampling, should reliably represent soil composition patterns for all depth zones. The average element content of each depth zone is given in Table 2.

The location (L), section (S(L)), and profile (P(LS)) variance components represent the nested portion of the ANOVA design (Table 1). These components estimate variation over increments of lateral distance. The distance between profiles is less-than 300 ft (100 m), between sections is from one-half to 2 miles (0.8 to 3.2 km), and between locations is from 2 to 24 miles (3.2 to 38.4 km). Most elements show significant variation between locations, sections, and profiles. This suggests that map patterns showing element distribution can be prepared by choosing a sampling interval based on the resolution, or amount of detail, necessary to meet the objectives of the investigation. However, the stability of the map will depend on the element's variance with distance. Selenium, for example, shows 65 percent of its total variation between locations, and nearly 75 percent of its total variation between locations plus sections. A map prepared for selenium based on a sampling interval of about 12 miles would show the gross distribution of selenium on the irrigated landscape, and a 2-mile or less sampling grid would reproduce the detail of the landscape with greater resolution.

Grid Sampling

Composite samples were collected from fields in 109 sections (Fig. 2.). The ANOVA study indicates that maps showing significant variation in element concentration can be prepared for as many as 20 to 28 of the 33 elements, depending on the desired resolution, using the grid-sampling data. Of these 28, only cerium, lanthanum, lead, mercury, neodymium, and thorium might be questionable because of their high analytical error component. Data for

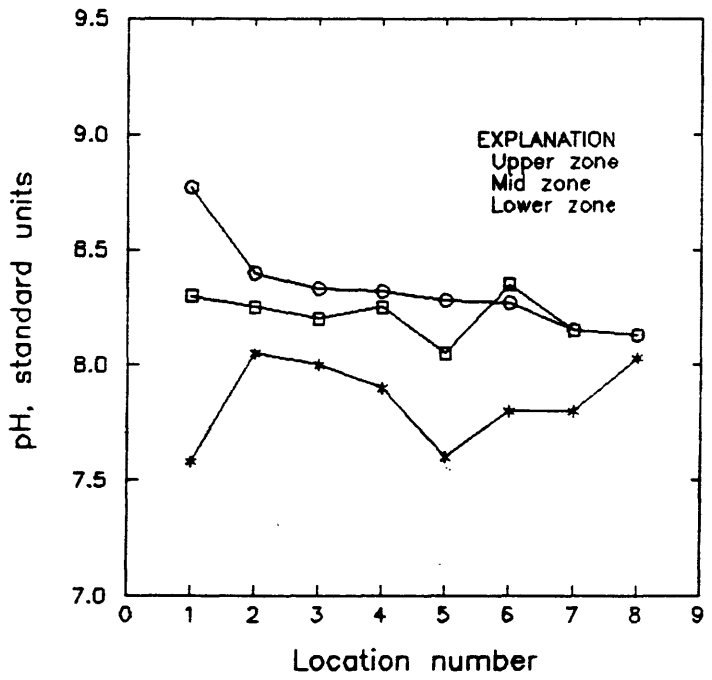

Figure 3. Analysis-of-variance interaction for location by sampling-depth zone, illustrated for pH.

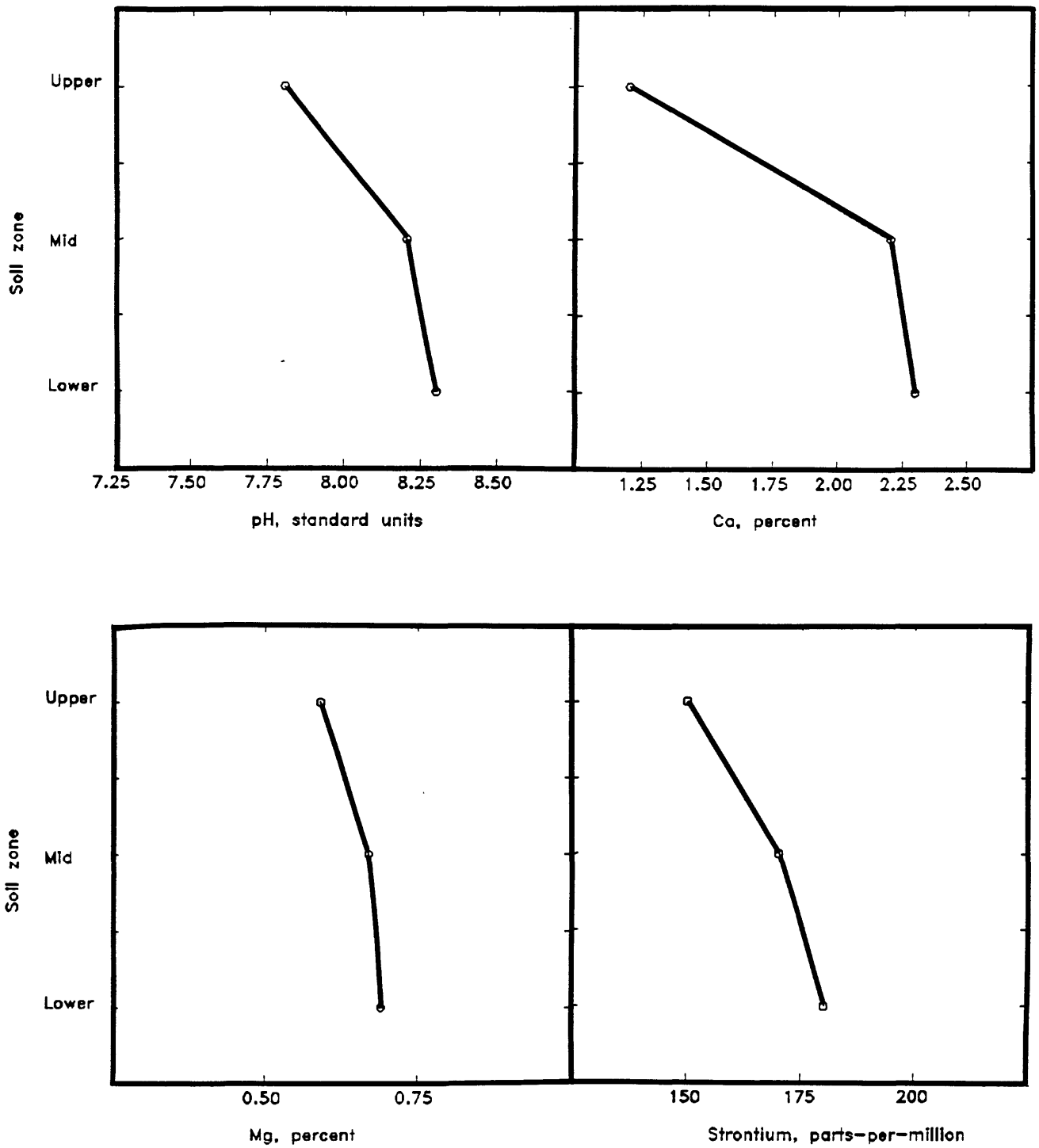

Fig. 4.--Plot of geometric means for elements with significant differences between sampling-depth zones (horizons), as determined by analysis-of-variance.

elements with no significant variation at distance increments of one-half mile or greater (S(L) plus L components in Table 1), when plotted on a map, would show no true landscape patterns of element distribution. The elements which cannot be reliably represented by a map are pH, barium, beryllium, mercury, and lead.

Selenium is used as an example of the element-concentration maps that can be prepared by using the data from the 109 grid samples (Fig. 5). The map contours were computed by averaging the four nearest neighbors and applying an inverse-distance-squared algorithm. Map representations of element concentrations are useful in determining the extent of areas above or below normal. They are also useful as an aid in interpreting the possible causes for the observed patterns. Similar determinations of the extent of extreme areas and their possible causes can be made from interpretations of maps prepared from the grid-sampling data for an additional 19 to 27 elements.

Average concentrations for 33 elements in ANOVA, grid, and northern Great Plains soils are given in Table 2. The average concentration of most elements in KRPA soils (grid and upper-, mid-, and lower-zone ANOVA samples) are similar to the average concentration for northern Great Plains soils. Contrasts of element concentrations are best made by considering both average concentration and variability. An expected range (Tidball and Ebens, 1976) is computed as the geometric mean (GM) amd the geometric deviation (GD) by: GM/GD^2 to $GM \times GD^2$ for northern Great Plains soils and is displayed graphically in Fig. 6. Statistically, 95 percent of the time, a sample collected in the northern Great Plains will fall within this range in element concentration. This range is commonly used and it could be altered to encompass any other percentages deemed appropriate. Average values for KRPA soils from the grid sampling are shown on the expected range graph of each element as X's (Fig. 6). This interpretive graph shows that the average concentrations for all elements are not only within the 95 percent expected range, but are very close to the geometric mean. When the observed ranges in element concentration of individual samples from the KRPA (Table 3) are compared to the expected ranges from soils of the northern Great Plains, as would be expected, a few elements exhibit values for at least one sample that are either above or below the expected range.

SUMMARY

Analysis-of-variance and grid-sampling designs are used to describe the geochemistry, both laterally and with depth, of irrigated agricultural soils at the Kendrick Reclamation Project Area. Significant differences in geochemical composition among soil depth zones were not found for most elements determined. Significant lateral variation in geochemical composition was found for most elements at all intervals measured. Therefore, using the grid data, maps of element concentrations in soils can be prepared for most elements, and these maps would reliably reproduce the natural geochemical patterns of the landscape.

The concentrations of most elements in the Kendrick Reclamation Project Area soils are within the typical range for soils from the northern Great Plains. The element concentrations given in this report are total (except for boron), and represent the abundance but not necessarily the soluble or available amounts for transport in ground water or uptake by plants.

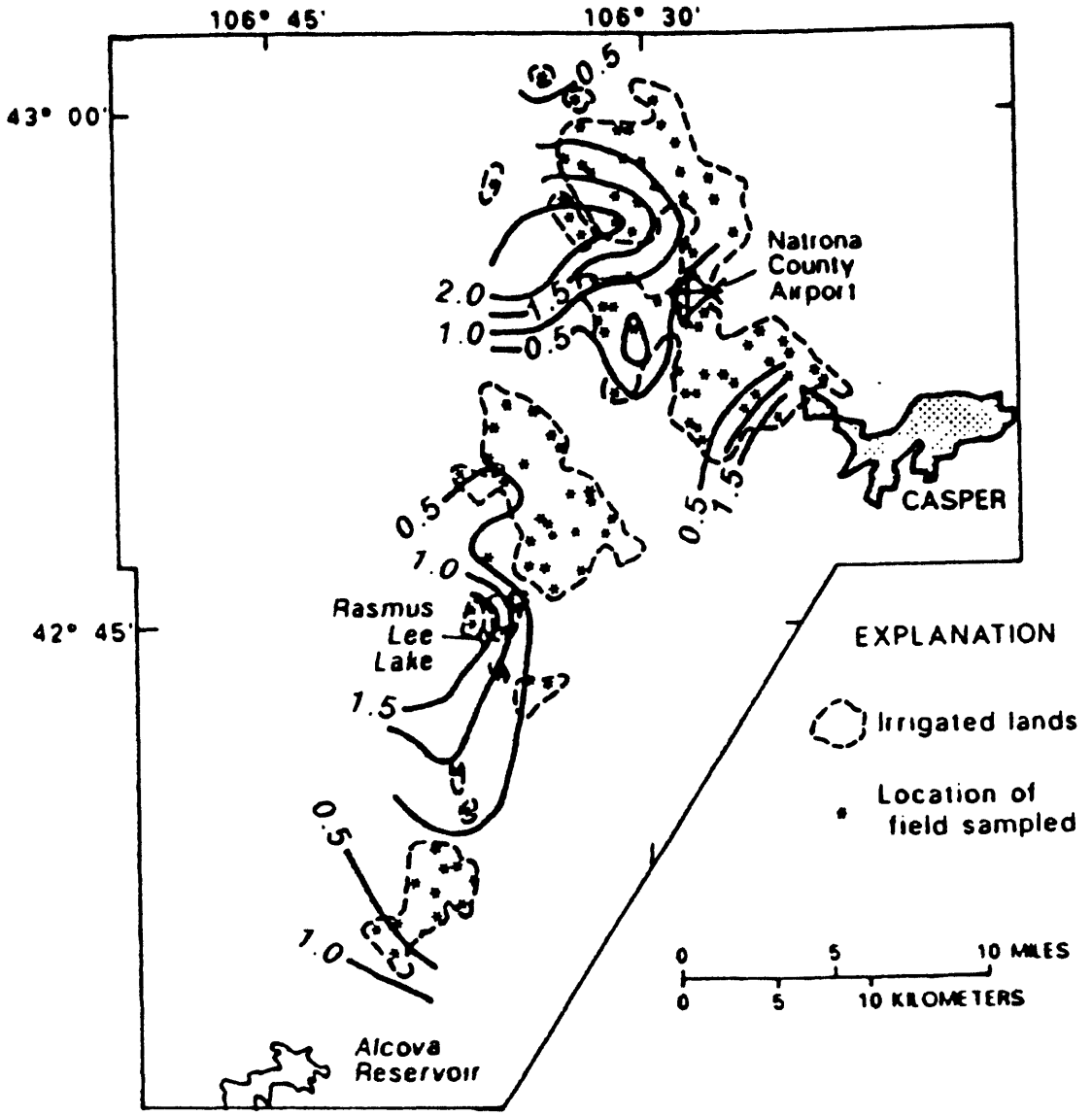

Figure 5. Contour map showing the distribution of selenium (ppm) in agricultural soils collected from irrigated lands at the Kendrick Reclamation Project Area.

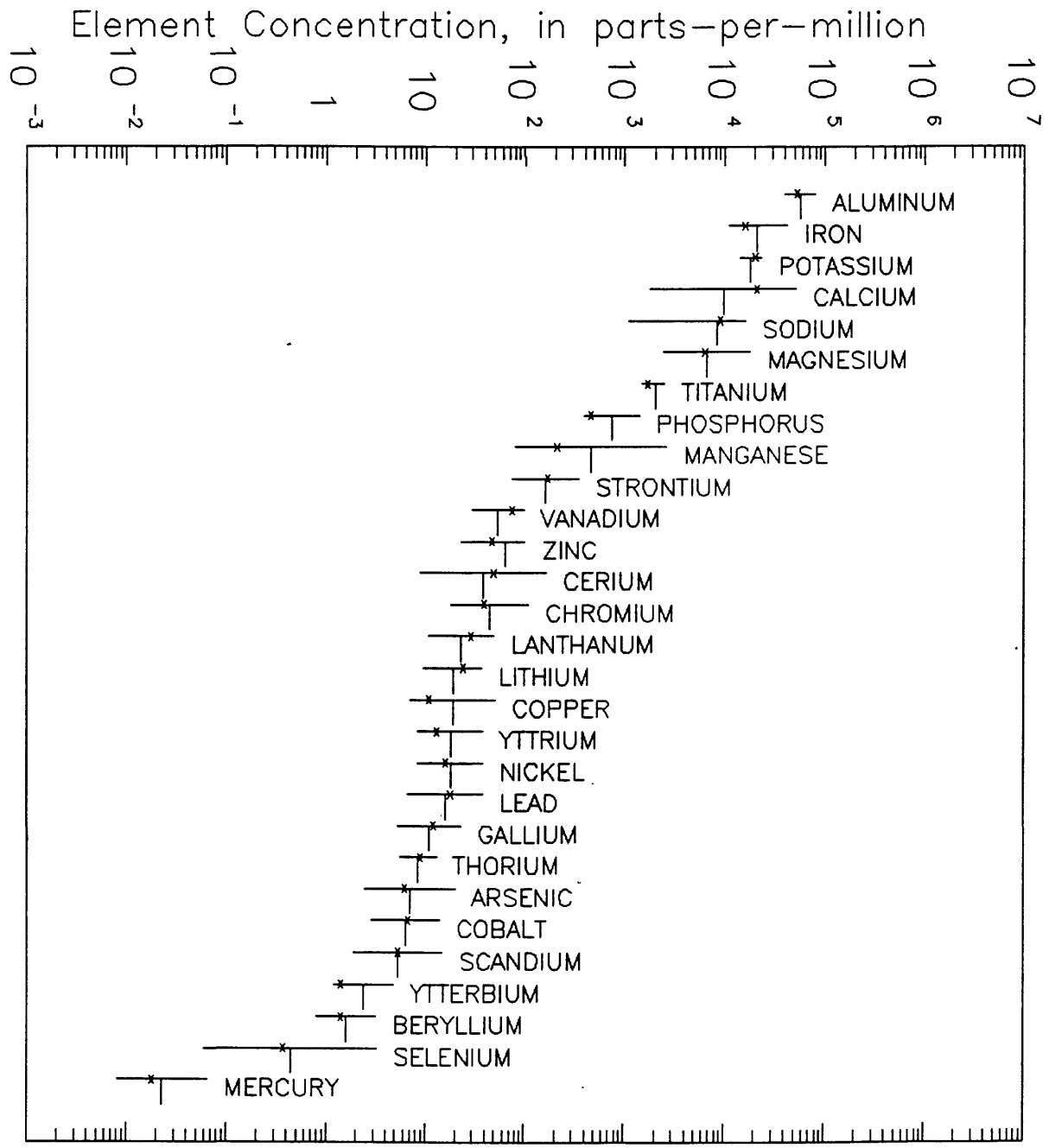

Fig. 6.--Expected 95-percent range (horizontal bars) and geometric mean (vertical bars) for element concentations in soils from the northern Great Plains, and average (x's) element concentration in soils from grid sampling loctions at the Kendrick Reclamation Project Area.

REFERENCES CITED

Bennett, C.A., and N.L. Franklin, 1967, Statistical analysis in chemistry and the chemical industry (Fifth Printing): John Wiley and Sons, New York, N.Y. 724 p.

Crock, J.G. and Lichte, F.E., 1982, An improved method for the determination of trace levels of arsenic and antimony in geologic materials by automated hydride generation-atomic absorption spectroscopy: Analytica Chemica Acta v. 144, p. 223-233.

Crock, J.G., Lichte, F.E., and Briggs, P.E., 1983, Determination of elements in National Bureau of Standards Geologic Reference Materials SRM 278 obsidian and SRM 688 basalt by inductively coupled argon plasma-atomic emission spectrometry: Geostandards Newsletter v. 7, p. 335-340.

Crock, J.G. and Severson, R.C., 1980, Four reference soil and rock samples for measuring element availability in the Western Energy Regions: U.S. Geological Survey Circular 841, 16 p.

Kennedy, K.R. and Crock, J.G., 1987, Determination of mercury in geologic materials by continuous flow, cold vapor, atomic absorption spectrophotometry: Analytical Letters, v. 20, p. 899-908.

Peterson, D.A., Jones, W.E., and Morton, A.G., 1988, Reconnaissance investigations of water quality, bottom sediment, and biota associated with irrigation drainage in the Kendrick Reclamation Project Area: U.S. Geological Survey Water-Resources Investigations Report 87-4255, 57 p.

Sanzolone, R.F. and Chao, T.T., 1987, Determination of selenium in thirty two geochemical reference materials by continuous-flow hydride generation atomic absorption spectrophotometry: Geostandards Newsletter, v. 11, p. 81-85.

Severson, R.C. and Tidball, R.R., 1979, Spatial variation in total element concentration in soil within the northern Great Plains coal region: U.S. Geological Survey Professional Paper 1134-A, 18 p.

Severson, R.C., Tidball, R.R., and Wilson, S.A., 1987, Chemical composition and variability of soils in the western San Joaquin Valley, California, p. 75-87, in, J.B. Summers (ed.), Toxic Substances in Agricultural Water Supply and Drainage, U.S. Committee on Irrigation and Drainage, Denver, CO, 358 p.

Severson, R.C., Wilson, S.A., and McNeal, J.M., 1987, Analyses of bottom material collected at nine areas in the western United States for the DOI irrigation drainage task group: U.S. Geological Survey Open-File Report 87-490, 24 p.

Tidball, R.R., and Ebens, R.J., 1976, Regional geochemical baselines in soils of the Powder River Basin, Montana-Wyoming: in Laudon, R.B. ed., Geology and energy resources of the Powder River: Wyoming Geological Association Guidebook, Twenty-eighth annual field conference, Casper, Wyoming, September 1976, p. 299-310.

Table 1. Variance components expressed as a percentage of total variance for pH and elements measured in three soil sampling depth zones from irrigated land at the Kendrick Reclamation Project Area.

Variable	Total log10 variance	Percentage of total variation by component[a]							
		L	S(L)	P(LS)	H	LH	SH(L)	PH(LS)	E
pH	0.14130	0.0	2.8	14.4*	42.9*	13.8*	3.8	21.1	1.2
Al	0.00263	0.0	61.2*	16.4*	0.7	0.0	0.3	14.1	7.2
As	0.04897	43.8*	0.0	10.0	0.0	1.4	0.0	18.5	26.3
B	0.10273	33.7*	0.0	26.4*	4.5	10.9*	0.0	21.4	3.0
Ba	0.05730	0.0	7.7	0.0	1.1	34.6*	0.0	56.2	0.5
Be	0.02589	12.4	16.4	10.9	0.0	5.6	0.0	54.7	0.0
Ca	0.12337	57.2*	0.0	4.1*	21.2*	2.2	5.7*	9.1	0.5
Ce	0.00935	39.8*	9.9	0.0	0.0	12.3*	0.0	0.0	>37.9
Co	0.02016	50.0*	19.7*	7.9*	0.0	0.0	8.4*	6.1	7.9
Cr	0.03531	42.9	28.9*	6.5*	0.0	0.0	8.5*	9.8	3.3
Cu	0.03359	60.9*	12.0*	6.5*	0.0	0.7	3.0	0.0	>17.0
Fe	0.01987	50.0*	21.6*	9.3*	0.0	0.6	4.0	8.1	6.4
Ga	0.00373	1.8	36.1*	21.1*	0.0	0.0	11.0	23.5	6.4
Hg	0.03639	3.0	0.0	28.0*	0.3	0.0	14.9	0.0	>53.8
K	0.00361	21.7	48.5*	5.7*	0.0	2.0	7.6*	3.8	10.8
La	0.00809	43.0*	9.1	0.0	0.3	10.4*	0.0	0.0	>37.3
Li	0.03755	42.8	25.9*	8.3*	0.6	0.0	9.3*	9.4	3.8
Mg	0.03663	50.1*	14.6*	6.6*	2.8*	1.6	11.1*	9.5	3.7
Mn	0.01881	53.1*	26.0*	4.7*	1.3	1.8	2.1	6.0	4.9
Na	0.02712	24.6	51.7*	4.6*	0.0	1.6	7.8*	9.7	0.0
Nd	0.01017	46.8*	8.8	4.4	0.1	4.1	0.0	0.0	>35.7
Ni	0.03910	67.0*	13.8*	4.5*	0.0	1.7	3.3	5.4	4.3
P	0.01968	48.1*	16.8*	8.1*	1.5	0.0	5.4	2.9	17.1
Pb	0.00403	1.8	9.5	13.7	2.1	11.4	0.0	12.6	48.9
Sc	0.02573	46.6*	17.7*	8.5*	0.0	3.0	4.8	8.1	11.2
Se	0.20880	65.3*	9.2*	4.8	0.4	2.2	1.3	4.7	12.1
Sr	0.01735	26.0	42.1*	5.5*	11.2*	7.4*	1.6	3.5	2.7
Th	0.01424	28.4*	11.3	0.0	0.0	8.6	0.0	0.0	>51.7
Ti	0.01474	50.2*	14.5*	8.2*	0.0	3.6	3.4	8.2	12.0
V	0.06288	60.7*	24.5*	4.1*	0.0	0.0	2.9	6.6	1.3
Y	0.01024	46.3*	19.8*	6.4	0.0	3.9	0.0	9.1	14.5
Yb	0.02352	49.2*	1.0	7.2	0.0	0.0	20.0*	22.6	0.0
Zn	0.04190	56.9*	18.9*	5.5*	0.0	3.5	4.3	6.7	4.1

[a]Components:

L, between locations

S(L), between sections within locations

P(LS), between profiles within locations and sections

H, between depth-zones

LH, location x depth-zone interaction

SH(L), section x depth-zone interaction within location

PH(LS), profile x depth-zone interaction within locations and sections

E, estimated procedural error

*Variance component significant at the 0.05 probability level

Table 2. Summary statistics for total-element concentrations, pH, and water-soluble boron measured in soils from analysis-of-variance and gridded agricultural field sampling locations in the Kendrick Reclamation Project Area, and data for the northern Great Plains.

Variable, unit of measure	Analysis-of-variance locations						Field locations		Northern Great Plains[a]	
	Surface zone		Mid zone		Lower zone		1-M Composite		A horizon	
	GM[b]	GD[c]	GM	GD	GM	GD	GM	GD	GM	GD
pH, std.	7.8[d]	0.25[d]	8.2[d]	0.25[d]	8.3[d]	0.30[d]	8.1[d]	0.23[d]	---[e]	---
Al, %	5.3	1.10	5.4	1.12	5.3	1.12	5.2	1.12	5.6	1.19
As, ppm	6.0	1.49	6.4	1.73	5.9	1.62	6.2	1.57	7.1	1.69
B, ppm[f]	1.0	1.34	1.1	2.07	1.4	2.28	1.1	1.67	---	---
Ba, ppm	640	1.15	670	1.20	520	2.12	630	1.35	1100	1.33
Be, ppm	1.5	1.41	1.6	1.40	1.5	1.42	1.4	1.41	1.6	1.42
Ca, %	1.2	2.04	2.2	2.06	2.3	1.88	2.1	1.82	0.97	2.30
Ce, ppm	52	1.15	52	1.24	54	1.26	49	1.20	38	2.08
Co, ppm	6.9	1.28	6.9	1.44	7.1	1.39	6.7	1.34	6.4	1.48
Cr, ppm	41	1.36	40	1.59	41	1.59	39	1.46	45	1.56
Cu, ppm	12	1.40	12	1.57	12	1.53	11	1.51	19	1.64
Fe, %	1.8	1.27	1.7	1.42	1.7	1.41	1.6	1.35	2.1	1.41
Ga, ppm	12	1.13	13	1.16	12	1.15	12	1.16	11	1.44
Hg, ppm	0.019	1.57	0.020	1.50	0.021	1.60	0.018	1.64	0.023	1.68
K, %	2.0	1.13	2.0	1.16	2.0	1.14	2.0	1.15	1.8	1.13
La, ppm	30	1.16	31	1.22	32	1.23	29	1.18	23	1.47
Li, ppm	23	1.37	25	1.61	26	1.62	24	1.52	19	1.40
Mg, %	0.59	1.39	0.67	1.57	0.69	1.59	0.63	1.57	0.66	1.67
Mn, ppm	240	1.27	220	1.39	220	1.40	210	1.34	460	2.38
Na, %	0.85	1.35	0.64	3.10	0.85	1.51	0.89	1.36	0.83[d]	0.36[d]
Nd, ppm	24	1.19	24	1.28	25	1.26	23	1.23	---	---
Ni, ppm	15	1.38	16	1.61	16	1.65	16	1.49	18	1.46
P, %	0.045	1.34	0.046	1.38	0.049	1.37	0.046	1.37	0.074	1.37
Pb, ppm	18	1.09	18	1.13	17	1.20	18	1.18	16	1.54
Sc, ppm	5.5	1.30	5.6	1.46	5.6	1.48	5.3	1.38	5.4	1.67
Se, ppm	0.32	2.29	0.37	3.02	0.40	2.99	0.37	2.85	0.45	2.72
Sr, ppm	150	1.29	170	1.32	180	1.35	170	1.26	160	1.47
Th, ppm	9.6	1.21	9.5	1.30	9.9	1.35	8.9	1.26	8.4	1.23
Ti, %	0.19	1.20	0.18	1.37	0.19	1.34	0.17	1.37	0.2[d]	0.023[d]
V, ppm	72	1.56	75	1.84	74	1.83	74	1.65	54	1.35
Y, ppm	15	1.20	15	1.28	15	1.26	13	1.26	18	1.46
Yb, ppm	1.7	1.37	1.8	1.31	1.7	1.39	1.4	1.45	2.4	1.41
Zn, ppm	52	1.36	50	1.66	48	1.68	47	1.52	63[d]	20[d]

[a] Data from Severson and Tidball, 1979
[b] Geometric mean
[c] Geometric deviation
[d] Arithmetic mean and standard deviation
[e] Not determined
[f] Water soluble

Table 3. Observed range and detection ratio for elements measured in soils from the grid sampling of agricultural soils in the Kendrick Reclamation Project Area.

[Detection ratio, number of samples above the lower detection limit and total number of samples]

Variable, unit of measure	Grid locations	
	Detection ratio	Observed range
pH, std.	119:119	7.5- 9.4
Al, %	119:119	3.8 - 7.6
As, ppm	119:119	2.1 - 15
Ba, ppm	119:119	77 -1100
Be, ppm	119:119	1.0 - 2.0
Ca, %	119:119	0.52- 8.8
Ce, ppm	119:119	30 - 72
Co, ppm	119:119	3.0 - 15
Cr, ppm	119:119	18 - 110
Cu, ppm	119:119	4.0 - 34
Fe, %	119:119	0.77- 3.6
Ga, ppm	119:119	9.0 - 20
Hg, ppm	56:119	<0.02- 0.06
K, %	119:119	0.96- 2.9
La, ppm	119:119	18 - 40
Li, ppm	119:119	10 - 69
Mg, %	119:119	0.21- 1.7
Mn, ppm	119:119	120 - 820
Na, %	119:119	0.24- 1.5
Nd, ppm	119:119	13 - 32
Ni, ppm	119:119	6.0 - 40
P, %	119:119	0.02- 0.08
Pb, ppm	119:119	12 - 41
Sc, ppm	119:119	2.0 - 13
Se, ppm	114:119	<0.1 - 3.8
Sr, ppm	119:119	87 - 300
Th, ppm	119:119	5.0 - 16
Ti, %	119:119	0.04- 0.37
V, ppm	119:119	29 - 230
Y, ppm	119:119	8.0 - 20
Yb, ppm	110:119	<1.0 - 2.0
Zn, ppm	119:119	19 - 130

Table A.--Listing of analytical data for samples from three horizons of agricultural soils collected from irrigated land at the Kendrick Reclamation Project Area.

[Sample ID coding is as follows, first two characters identify the eight locations (L1-L8) and an R in the first position indicates a laboratory split of the previous sample; the third and fourth characters, SC or SR, indicate sampling sites in adjacent sections within each location; the fifth and sixth characters, P1 or P2, indicate profiles collected within 100 meters of each other within sections; and the last two characters, H1, H2, or H3, indicate soil horizons collected from each profile.]

	Sample ID	Latitude	Longitude	pH	Al, %	As, ppm	B, ppm	Ba, ppm	Be, ppm	Ca, %	Ce, ppm
1	L1SCP1H1	42 37 33	106 38 24	8.0	5.0	4.2	0.6	650	1	1.7	50
2	L1SCP1H2			8.2	5.0	4.0	0.6	750	1	4.3	60
3	L1SCP1H3			8.4	4.7	5.1	0.5	760	1	2.6	110
4	L1SCP2H1			8.1	5.1	4.4	0.7	650	1	1.1	65
5	L1SCP2H2			8.2	5.3	2.9	0.7	690	1	2.6	60
6	L1SCP2H3			8.3	5.3	2.8	0.6	840	1	3.5	72
7	R1SCP2H3			8.2	5.0	5.2	0.5	790	1	3.5	45
8	L1SRP1H1	42 37 09	106 39 31	7.8	5.9	3.3	1.0	680	2	2.4	59
9	L1SRP1H2			8.2	5.9	2.1	0.6	840	2	3.0	50
10	L1SRP1H3			8.2	5.7	4.4	0.5	810	2	3.1	56
11	L1SRP2H1			8.1	5.7	2.9	0.9	780	2	3.3	60
12	L1SRP2H2			8.2	5.7	3.7	<0.4	870	1	3.2	52
13	L1SRP2H3			8.4	5.6	2.2	0.5	1000	1	3.5	85
14	L2SCP1H1	42 38 10	106 38 44	8.1	5.3	5.0	0.6	670	1	2.1	53
15	L2SCP1H2			8.2	5.7	5.6	0.5	680	2	2.1	67
16	L2SCP1H3			8.4	5.5	5.5	0.7	660	2	3.2	55
17	L2SCP2H1			7.9	5.4	4.2	0.7	650	2	1.1	51
18	L2SCP2H2			8.1	5.5	6.7	0.5	650	2	2.4	61
19	L2SCP2H3			8.3	5.8	6.0	0.7	720	2	3.4	65
20	L2SRP1H1	42 39 10	106 37 26	8.1	4.1	4.7	0.8	450	1	1.3	56
21	R2SRP1H1			8.1	4.1	5.1	0.7	430	1	1.3	55
22	L2SRP1H2			8.3	4.4	5.6	0.6	470	1	1.9	63
23	L2SRP1H3			8.3	4.2	7.3	0.8	450	1	1.6	55
24	L2SRP2H1			8.1	4.4	4.7	0.7	450	1	1.5	55
25	L2SRP2H2			8.4	4.3	4.0	0.6	430	1	2.4	58
26	L2SRP2H3			8.6	4.7	5.0	1.2	470	2	1.7	60
27	L3SCP1H1	42 48 16	106 32 26	8.2	5.1	6.0	1.1	590	2	1.4	55
28	L3SCP1H2			8.8	5.1	5.9	2.3	600	2	2.0	50
29	L3SCP1H3			8.2	5.7	5.0	3.1	450	2	2.4	59
30	L3SCP2H1			7.7	5.2	5.6	0.9	540	2	0.65	48
31	L3SCP2H2			8.1	4.8	7.8	0.8	570	1	1.6	56
32	R3SCP2H2			8.1	4.8	6.1	0.6	580	1	1.6	47
33	L3SCP2H3			8.3	4.7	6.5	0.8	700	1	2.4	50
34	L3SRP1H1	42 47 34	106 34 13	7.8	5.9	5.8	1.0	690	2	0.88	51
35	L3SRP1H2			8.0	5.9	10	0.8	700	2	5.0	50
36	L3SRP1H3			8.3	6.5	16	1.1	770	2	3.5	58
37	L3SRP2H1			7.9	6.3	8.6	0.9	710	2	1.9	56
38	L3SRP2H2			8.1	6.4	7.9	1.0	780	2	5.0	53
39	L3SRP2H3			8.5	6.6	9.6	8.7	780	2	3.0	58

Table A.--Listing of analytical data for samples from three horizons of agricultural soils collected from irrigated land at the Kendrick Reclamation Project Area (continued).

Sample ID	Latitude	Longitude	pH	Al, %	As, ppm	B, ppm	Ba, ppm	Be, ppm	Ca, %	Ce, ppm
40 L4SCP1H1	42 49 22	106 35 05	8.0	5.1	5.4	0.8	630	1	1.2	48
41 L4SCP1H2			8.2	6.3	7.6	1.0	850	2	3.5	57
42 L4SCP1H3			7.8	6.1	8.9	1.9	72	2	3.0	51
43 L4SCP2H1			7.8	5.3	5.2	0.8	650	2	0.77	56
44 L4SCP2H2			8.3	4.8	3.9	0.6	630	1	2.5	39
45 L4SCP2H3			8.5	5.3	4.3	0.8	650	1	2.1	36
46 L4SRP1H1	42 48 51	106 35 56	8.1	4.9	6.6	1.0	580	1	2.2	53
47 L4SRP1H2			8.2	4.9	5.5	0.9	630	1	2.8	55
48 L4SRP1H3			8.4	4.8	5.1	1.2	650	1	2.1	59
49 L4SRP2H1			8.2	6.5	7.4	1.6	660	2	2.1	64
50 L4SRP2H2			7.8	5.8	6.7	3.3	630	2	2.3	58
51 R4SRP2H2			7.8	5.9	8.3	3.2	630	2	2.3	61
52 L4SRP2H3			7.8	5.5	6.9	2.5	650	2	2.2	57
53 L5SCP1H1	42 50 52	106 34 45	8.1	5.1	5.5	1.1	600	2	0.73	55
54 L5SCP1H2			8.7	4.8	5.7	1.1	580	2	0.81	52
55 L5SCP1H3			8.7	4.9	5.5	0.9	600	1	1.0	55
56 L5SCP2H1			8.0	5.9	8.1	1.3	560	2	0.79	64
57 L5SCP2H2			8.2	5.9	6.5	3.3	590	2	1.3	60
58 L5SCP2H3			8.0	4.9	5.5	1.8	590	1	0.64	53
59 L5SRP1H1	42 51 02	106 35 47	7.4	5.1	5.4	1.1	590	1	0.57	52
60 L5SRP1H2			7.5	5.7	4.6	0.9	600	2	0.63	55
61 L5SRP1H3			7.8	5.4	3.9	0.9	650	1	0.59	44
62 L5SRP2H1			7.7	5.5	9.1	0.8	590	2	0.67	59
63 L5SRP2H2			8.2	6.1	9.6	1.7	620	2	0.88	65
64 L5SRP2H3			8.1	6.2	4.9	2.7	590	2	0.99	63
65 L6SCP1H1	42 53 23	106 28 33	7.7	5.3	7.2	1.3	620	2	0.45	47
66 L6SCP1H2			8.4	4.9	4.1	2.2	620	1	0.54	29
67 L6SCP1H3			9.3	5.2	4.2	3.0	650	1	1.7	47
68 L6SCP2H1			7.4	4.8	2.8	0.6	690	1	0.57	37
69 L6SCP2H2			8.2	5.4	<10	0.6	730	2	3.2	49
70 L6SCP2H3			8.4	4.9	<10	0.9	720	1	3.8	40
71 R6SCP2H3			8.5	4.7	5.5	0.7	700	1	3.2	29
72 L6SRP1H1	42 53 17	106 28 08	7.6	4.7	5.6	1.2	600	1	0.46	36
73 L6SRP1H2			8.3	4.5	2.1	0.9	620	1	1.8	25
74 L6SRP1H3			8.8	4.5	2.1	1.8	620	1	1.6	35
75 L6SRP2H1			7.6	4.7	6.2	0.7	590	1	0.45	39
76 R6SRP2H1			7.6	5.1	3.7	0.7	650	1	0.49	43
77 L6SRP2H2			8.3	4.6	28	0.5	620	1	0.87	35
78 L6SRP2H3			8.6	4.4	4.2	0.6	590	1	1.8	38

Table A.--Listing of analytical data for samples from three horizons of agricultural soils collected from irrigated land at the Kendrick Reclamation Project Area (continued).

Sample ID	Latitude	Longitude	pH	Al, %	As, ppm	B, ppm	Ba, ppm	Be, ppm	Ca, %	Ce, ppm
79 L7SCP1H1	42 49 08	106 37 38	7.4	5.4	5.6	1.4	600	2	0.58	60
80 L7SCP1H2			8.2	5.4	6.7	2.3	560	2	1.9	54
81 L7SCP1H3			8.4	4.7	6.7	1.2	580	1	1.5	58
82 L7SCP2H1			7.3	4.8	5.4	1.3	560	1	0.51	54
83 L7SCP2H2			8.0	5.3	7.6	0.8	580	2	1.2	64
84 L7SCP2H3			8.3	4.8	5.2	0.7	860	2	1.6	57
85 L7SRP1H1	42 49 31	106 36 30	7.8	5.9	6.9	1.4	780	2	0.57	47
86 L7SRP1H2			7.9	6.7	9.5	1.7	840	2	0.71	56
87 L7SRP1H3			8.2	6.1	5.2	3.4	770	2	1.6	49
88 L7SRP2H1			7.9	5.6	6.3	1.1	790	2	0.74	56
89 L7SRP2H2			8.1	5.8	5.8	0.9	800	2	0.92	57
90 L7SRP2H3			8.2	5.8	6.3	0.8	800	2	1.7	62
91 L8SCP1H1	42 55 59	106 32 41	7.9	5.1	10	1.2	800	2	3.2	50
92 L8SCP1H2			8.0	5.6	10	2.4	790	2	6.8	49
93 L8SCP1H3			8.3	5.6	8.8	5.0	670	2	6.4	53
94 L8SCP2P1			7.7	5.2	15	1.5	830	2	2.9	50
95 L8SCP2H2			8.3	5.8	10	5.4	920	2	6.5	51
96 L8SCP2H3			8.0	5.4	11	4.6	54	2	7.3	44
97 L8SRP1H1	42 56 28	106 33 05	7.8	5.2	14	1.5	660	2	4.3	48
98 L8SRP1H2			8.5	5.9	12	4.7	820	2	6.0	51
99 L8SRP1H3			8.3	5.2	13	6.0	49	2	7.8	45
100 L8SRP2H1			7.8	5.5	12	1.0	660	2	5.0	49
101 L8SRP2H2			8.6	5.6	14	1.7	800	2	6.6	49
102 L8SRP2H3			8.5	6.0	12	4.7	320	2	6.7	50

Table A.--Listing of analytical data for samples from three horizons of agricultural soils collected from irrigated land at the Kendrick Reclamation Project Area (continued).

	Sample ID	Co, ppm	Cr, ppm	Cu, ppm	Fe, %	Ga, ppm	Hg, ppm	K, %	La, ppm	Li, ppm	Mg, %
1	L1SCP1H1	6	31	10	1.4	12	0.02	1.9	31	15	0.50
2	L1SCP1H2	6	29	9	1.4	12	<0.02	2.0	37	18	0.60
3	L1SCP1H3	6	22	8	1.2	10	<0.02	2.0	58	14	0.43
4	L1SCP2H1	5	28	10	1.3	11	<0.02	2.1	36	13	0.43
5	L1SCP2H2	7	35	12	1.5	11	0.02	2.0	36	17	0.58
6	L1SCP2H3	6	30	10	1.4	11	0.02	2.1	45	16	0.55
7	R1SCP2H3	6	29	8	1.3	11	0.02	1.9	29	16	0.55
8	L1SRP1H1	8	44	15	2.0	14	<0.02	1.9	35	27	0.98
9	L1SRP1H2	5	21	7	1.1	12	0.02	2.6	31	13	0.46
10	L1SRP1H3	5	23	9	1.2	12	<0.02	2.5	32	15	0.51
11	L1SRP2H1	7	33	12	1.6	13	0.04	2.1	36	21	0.74
12	L1SRP2H2	4	19	7	1.0	13	<0.02	2.7	31	12	0.42
13	L1SRP2H3	5	20	7	1.0	12	0.04	2.5	51	11	0.39
14	L2SCP1H1	6	27	11	1.5	11	<0.02	2.0	29	19	0.65
15	L2SCP1H2	7	35	13	1.8	13	<0.02	2.1	36	24	0.79
16	L2SCP1H3	9	46	13	2.0	13	<0.02	1.9	34	26	1.0
17	L2SCP2H1	7	43	20	1.8	13	<0.02	2	30	21	0.67
18	L2SCP2H2	8	44	12	1.9	13	<0.02	1.9	34	26	0.81
19	L2SCP2H3	9	51	13	2.0	13	0.02	1.9	39	27	0.96
20	L2SRP1H1	8	52	10	1.7	11	<0.02	1.7	32	23	0.78
21	R2SRP1H1	7	46	12	1.7	11	<0.02	1.6	30	21	0.77
22	L2SRP1H2	9	59	12	2.0	11	0.02	1.7	34	25	0.79
23	L2SRP1H3	9	54	11	1.9	12	0.02	1.6	30	26	0.77
24	L2SRP2H1	8	56	14	1.7	10	<0.02	1.7	31	24	0.77
25	L2SRP2H2	7	50	10	1.6	10	<0.02	1.6	33	25	0.97
26	L2SRP2H3	9	62	15	1.7	12	<0.02	1.8	34	29	1.0
27	L3SCP1H1	7	34	15	1.7	11	<0.02	1.8	32	20	0.60
28	L3SCP1H2	8	33	12	1.7	10	<0.02	1.9	30	22	0.70
29	L3SCP1H3	7	34	15	2.0	13	<0.02	1.9	33	26	0.98
30	L3SCP2H1	7	33	11	1.7	12	0.02	2.0	28	20	0.53
31	L3SCP2H2	6	28	10	1.6	11	0.02	2.0	33	18	0.58
32	R3SCP2H2	6	28	13	1.6	12	<0.02	1.9	26	18	0.58
33	L3SCP2H3	7	27	11	1.5	11	<0.02	1.9	29	18	0.59
34	L3SRP1H1	7	47	12	2.1	13	<0.02	2.5	30	29	0.62
35	L3SRP1H2	11	69	18	2.5	16	0.04	1.9	32	50	1.5
36	L3SRP1H3	11	85	19	2.6	16	0.04	2.0	33	58	1.7
37	L3SRP2H1	8	65	15	2.4	14	0.04	2.3	35	38	0.89
38	L3SRP2H2	11	78	18	2.7	16	0.04	1.9	34	59	1.7
39	L3SRP2H3	12	89	19	2.8	17	0.04	2.1	35	66	1.9

Table A.--Listing of analytical data for samples from three horizons of agricultural soils collected from irrigated land at the Kendrick Reclamation Project Area (continued).

Sample ID	Co, ppm	Cr, ppm	Cu, ppm	Fe, %	Ga, ppm	Hg, ppm	K, %	La, ppm	Li, ppm	Mg, %
40 L4SCP1H1	6	38	12	1.7	12	<0.02	2.2	29	22	0.50
41 L4SCP1H2	11	73	16	2.8	16	0.04	2.0	34	57	1.2
42 L4SCP1H3	10	78	16	2.8	14	0.06	1.9	30	62	1.3
43 L4SCP2H1	6	36	9	1.8	12	<0.02	2.1	33	23	0.51
44 L4SCP2H2	5	30	7	1.2	11	<0.02	2.3	25	17	0.46
45 L4SCP2H3	6	42	11	1.5	12	0.04	2.4	23	26	0.70
46 L4SRP1H1	8	45	13	1.7	12	0.04	1.6	32	25	0.60
47 L4SRP1H2	7	41	14	1.7	11	<0.02	1.5	33	24	0.65
48 L4SRP1H3	8	40	14	1.7	10	0.02	1.7	34	25	0.68
49 L4SRP2H1	10	65	18	2.4	16	<0.02	1.9	38	38	0.92
50 L4SRP2H2	9	54	18	2.1	15	0.02	1.8	34	31	0.81
51 R4SRP2H2	9	55	19	2.1	15	0.02	1.8	37	32	0.82
52 L4SRP2H3	10	54	13	2.1	14	<0.02	1.9	33	31	0.84
53 L5SCP1H1	5	27	9	1.6	13	<0.02	1.8	30	22	0.49
54 L5SCP1H2	4	28	6	1.4	12	0.02	1.7	29	19	0.42
55 L5SCP1H3	4	28	7	1.3	11	<0.02	1.9	29	19	0.42
56 L5SCP2H1	6	40	10	2.0	15	0.02	1.7	36	26	0.64
57 L5SCP2H2	6	43	14	1.9	14	0.02	1.8	34	28	0.67
58 L5SCP2H3	5	27	9	1.4	12	0.04	1.8	29	19	0.41
59 L5SRP1H1	6	34	8	1.5	13	0.02	2.0	29	19	0.45
60 L5SRP1H2	6	40	10	1.9	13	0.04	2.1	30	24	0.57
61 L5SRP1H3	6	33	11	1.4	12	0.02	2.4	26	18	0.44
62 L5SRP2H1	6	37	9	1.7	12	<0.02	1.9	32	22	0.48
63 L5SRP2H2	7	33	12	2.1	15	<0.02	2.0	38	27	0.65
64 L5SRP2H3	7	44	13	2.0	14	0.02	1.9	35	27	0.65
65 L6SCP1H1	6	37	11	1.5	12	0.02	2.3	25	20	0.47
66 L6SCP1H2	4	24	6	1.0	11	0.02	2.5	16	14	0.33
67 L6SCP1H3	5	28	9	1.1	12	0.02	2.5	29	19	0.43
68 L6SCP2H1	5	27	8	1.2	9	0.02	2.4	21	14	0.29
69 L6SCP2H2	7	42	10	1.6	13	0.04	2.4	31	25	0.58
70 L6SCP2H3	6	25	8	1.3	11	0.04	2.3	26	23	0.51
71 R6SCP2H3	5	23	6	1.2	11	<0.02	2.4	19	18	0.41
72 L6SRP1H1	4	24	6	1.0	11	0.04	2.4	20	13	0.28
73 L6SRP1H2	3	15	4	0.6	9	<0.02	2.3	17	9	0.23
74 L6SRP1H3	3	17	4	0.7	9	<0.02	2.4	21	11	0.29
75 L6SRP2H1	4	24	5	1.0	11	0.04	2.3	21	13	0.28
76 R6SRP2H1	5	30	10	1.3	12	<0.02	2.5	25	15	0.34
77 L6SRP2H2	3	14	6	0.8	11	0.04	2.4	20	11	0.26
78 L6SRP2H3	4	19	5	0.8	9	0.02	2.3	23	12	0.32

Table A.--Listing of analytical data for samples from three horizons of agricultural soils collected from irrigated land at the Kendrick Reclamation Project Area (continued).

	Sample ID	Co, ppm	Cr, ppm	Cu, ppm	Fe, %	Ga, ppm	Hg, ppm	K, %	La, ppm	Li, ppm	Mg, %
79	L7SCP1H1	8	53	15	1.9	12	0.02	1.9	34	26	0.57
80	L7SCP1H2	8	51	14	1.8	13	0.02	1.7	32	28	0.63
81	L7SCP1H3	7	41	11	1.6	13	0.02	1.6	34	24	0.56
82	L7SCP2H1	7	45	12	1.7	11	0.02	1.7	30	23	0.45
83	L7SCP2H2	8	50	15	1.8	12	0.02	1.7	34	27	0.59
84	L7SCP2H3	8	44	12	1.7	11	<0.02	1.7	34	25	0.56
85	L7SRP1H1	10	65	15	2.7	14	0.02	2.2	27	35	0.63
86	L7SRP1H2	10	68	20	2.7	16	0.02	2.2	34	45	0.85
87	L7SRP1H3	10	65	14	2.4	14	0.02	2.2	29	40	0.84
88	L7SRP2H1	9	55	15	2.4	13	<0.02	2.2	31	33	0.66
89	L7SRP2H2	10	61	15	2.6	14	<0.02	1.9	33	34	0.66
90	L7SRP2H3	9	59	14	2.6	13	<0.02	2.1	36	37	0.75
91	L8SCP1H1	10	57	19	2.4	13	0.02	1.8	31	33	0.80
92	L8SCP1H2	10	45	22	2.2	13	0.02	1.7	31	41	1.0
93	L8SCP1H3	9	63	24	2.1	13	<0.02	1.8	34	41	1.0
94	L8SCP2P1	9	58	18	2.3	11	<0.02	1.8	29	34	0.82
95	L8SCP2H2	10	68	24	2.2	13	0.02	1.6	32	41	1.1
96	L8SCP2H3	8	65	18	2.0	12	0.02	1.7	27	42	1.0
97	L8SRP1H1	8	55	18	2.0	13	0.04	1.8	31	32	0.81
98	L8SRP1H2	9	74	23	2.2	14	0.04	1.8	31	42	1.0
99	L8SRP1H3	8	55	22	2.0	14	0.04	1.7	28	40	0.96
100	L8SRP2H1	9	51	20	2.0	14	<0.02	1.8	31	33	0.87
101	L8SRP2H2	9	65	21	2.1	13	<0.02	1.7	28	39	1.1
102	L8SRP2H3	9	72	28	2.3	14	0.02	1.9	32	46	1.2

Table A.--Listing of analytical data for samples from three horizons of agricultural soils collected from irrigated land at the Kendrick Reclamation Project Area (continued).

	Sample ID	Mn, ppm	Mo, ppm	Na, %	Nb, ppm	Nd, ppm	Ni, ppm	P, %	Pb, ppm	Sc, ppm	Se, ppm
1	L1SCP1H1	250	<2	1.3	<4	21	10	0.04	17	5	0.1
2	L1SCP1H2	230	<2	1.2	<4	27	11	0.04	17	5	0.2
3	L1SCP1H3	200	<2	1.3	<4	42	8	0.03	18	4	0.1
4	L1SCP2H1	240	<2	1.3	<4	25	10	0.04	18	4	0.1
5	L1SCP2H2	270	<2	1.3	<4	28	11	0.04	19	5	0.2
6	L1SCP2H3	210	<2	1.4	<4	29	10	0.03	19	4	0.2
7	R1SCP2H3	210	<2	1.4	<4	23	11	0.03	17	4	0.1
8	L1SRP1H1	340	<2	1.1	8	27	14	0.07	17	7	0.2
9	L1SRP1H2	280	<2	1.8	<4	23	7	0.04	17	4	0.1
10	L1SRP1H3	310	<2	1.6	<4	25	8	0.05	16	4	0.1
11	L1SRP2H1	350	<2	1.3	<4	32	10	0.06	18	6	0.2
12	L1SRP2H2	300	<2	1.8	<4	22	6	0.04	17	3	0.1
13	L1SRP2H3	350	<2	1.8	<4	38	6	0.05	20	3	0.1
14	L2SCP1H1	230	<2	1.2	<4	23	12	0.04	18	5	0.1
15	L2SCP1H2	270	<2	1.1	<4	28	16	0.04	18	6	0.2
16	L2SCP1H3	300	<2	1.1	<4	28	18	0.05	17	7	0.2
17	L2SCP2H1	270	<2	1.1	<4	23	15	0.04	16	6	0.1
18	L2SCP2H2	260	<2	0.99	<4	26	16	0.05	17	6	0.1
19	L2SCP2H3	280	<2	1.1	<4	33	18	0.05	19	7	0.3
20	L2SRP1H1	330	<2	0.43	<4	26	17	0.04	18	6	0.1
21	R2SRP1H1	320	<2	0.43	<4	26	15	0.05	15	6	0.2
22	L2SRP1H2	390	<2	0.42	<4	29	19	0.04	19	6	0.5
23	L2SRP1H3	400	<2	0.39	<4	26	20	0.04	16	6	0.1
24	L2SRP2H1	300	<2	0.44	<4	26	17	0.05	20	6	0.2
25	L2SRP2H2	250	<2	0.43	<4	27	16	0.05	14	6	0.2
26	L2SRP2H3	270	<2	0.42	<4	28	20	0.05	20	7	0.3
27	L3SCP1H1	300	<2	0.88	6	26	14	0.05	18	5	0.6
28	L3SCP1H2	310	<2	0.80	<4	24	13	0.05	16	5	0.5
29	L3SCP1H3	340	<2	0.78	<4	28	14	0.06	17	7	0.4
30	L3SCP2H1	280	<2	0.86	<4	25	12	0.04	17	5	0.4
31	L3SCP2H2	330	<2	0.80	<4	26	12	0.04	17	5	0.1
32	R3SCP2H2	280	<2	0.79	<4	22	12	0.04	17	5	0.2
33	L3SCP2H3	310	<2	0.81	<4	23	12	0.05	17	5	0.3
34	L3SRP1H1	290	<2	1.0	<4	23	17	0.06	21	6	0.4
35	L3SRP1H2	310	<2	0.45	<4	27	23	0.07	19	9	0.4
36	L3SRP1H3	310	<2	0.42	<4	28	27	0.09	20	10	0.7
37	L3SRP2H1	270	<2	0.77	<4	27	20	0.06	23	8	0.4
38	L3SRP2H2	320	<2	0.42	<4	29	26	0.09	19	10	0.6
39	L3SRP2H3	260	<2	0.44	6	29	26	0.09	20	11	2.0

Table A.--Listing of analytical data for samples from three horizons of agricultural soils collected from irrigated land at the Kendrick Reclamation Project Area (continued).

Sample ID	Mn, ppm	Mo, ppm	Na, %	Nb, ppm	Nd, ppm	Ni, ppm	P, %	Pb, ppm	Sc, ppm	Se, ppm
40 L4SCP1H1	220	<2	1.0	<4	21	15	0.04	18	5	0.3
41 L4SCP1H2	190	<2	0.56	<4	29	27	0.07	16	9	0.9
42 L4SCP1H3	180	<2	0.42	<4	27	25	0.07	14	10	1.3
43 L4SCP2H1	220	<2	0.99	<4	25	16	0.04	20	5	0.4
44 L4SCP2H2	190	<2	1.1	<4	17	12	0.03	18	4	0.1
45 L4SCP2H3	200	<2	1.1	<4	17	13	0.04	20	5	0.2
46 L4SRP1H1	240	<2	0.64	<4	26	16	0.05	19	6	0.3
47 L4SRP1H2	220	<2	0.69	7	25	16	0.05	16	6	0.5
48 L4SRP1H3	230	<2	0.68	<4	26	17	0.05	18	6	0.5
49 L4SRP2H1	310	<2	0.53	8	32	23	0.06	18	9	0.6
50 L4SRP2H2	270	2	0.67	<4	28	20	0.06	17	7	1.4
51 R4SRP2H2	270	<2	0.68	<4	29	21	0.06	18	8	1.5
52 L4SRP2H3	350	<2	0.80	<4	28	20	0.06	17	7	1.3
53 L5SCP1H1	180	<2	0.87	<4	24	12	0.04	20	5	0.6
54 L5SCP1H2	130	<2	0.94	<4	24	11	0.04	16	4	0.4
55 L5SCP1H3	130	<2	1.0	<4	23	9	0.05	14	4	0.4
56 L5SCP2H1	170	<2	0.73	<4	28	15	0.04	17	6	0.2
57 L5SCP2H2	170	<2	0.82	<4	29	15	0.05	18	6	0.6
58 L5SCP2H3	140	<2	0.97	<4	22	10	0.04	16	4	0.5
59 L5SRP1H1	180	<2	0.92	<4	23	12	0.04	17	5	0.1
60 L5SRP1H2	230	<2	0.88	<4	22	15	0.04	20	6	0.2
61 L5SRP1H3	300	<2	1.1	<4	20	13	0.04	19	4	0.2
62 L5SRP2H1	200	<2	0.84	5	24	12	0.05	19	5	0.2
63 L5SRP2H2	210	<2	0.82	6	30	15	0.05	27	7	0.2
64 L5SRP2H3	190	<2	0.88	<4	29	14	0.06	20	6	0.4
65 L6SCP1H1	200	<2	1.0	<4	20	13	0.04	18	5	0.4
66 L6SCP1H2	130	<2	1.2	<4	12	9	0.02	18	3	0.3
67 L6SCP1H3	150	<2	1.3	<4	21	9	0.03	21	4	0.2
68 L6SCP2H1	190	<2	1.1	<4	17	9	0.03	17	3	0.4
69 L6SCP2H2	180	<2	1.0	<4	23	17	0.04	13	5	0.4
70 L6SCP2H3	170	<2	1.1	<4	20	13	0.03	12	4	0.3
71 R6SCP2H3	150	<2	1.1	<4	12	10	0.03	15	3	0.2
72 L6SRP1H1	140	<2	1.1	<4	14	9	0.02	17	3	0.1
73 L6SRP1H2	110	<2	1.3	<4	11	6	0.03	18	<2	0.1
74 L6SRP1H3	100	<2	1.3	<4	13	7	0.03	18	2	0.1
75 L6SRP2H1	150	<2	1.2	<4	17	9	0.02	17	3	0.2
76 R6SRP2H1	170	<2	1.2	5	20	10	0.03	20	4	0.2
77 L6SRP2H2	91	<2	1.2	<4	15	9	0.02	17	3	<0.1
78 L6SRP2H3	130	<2	1.3	<4	15	8	0.03	16	3	0.1

Table A.--Listing of analytical data for samples from three horizons of agricultural soils collected from irrigated land at the Kendrick Reclamation Project Area (continued).

	Sample ID	Mn, ppm	Mo, ppm	Na, %	Nb, ppm	Nd, ppm	Ni, ppm	P, %	Pb, ppm	Sc, ppm	Se, ppm
79	L7SCP1H1	300	<2	0.63	<4	29	17	0.05	19	6	0.5
80	L7SCP1H2	220	<2	0.53	<4	27	18	0.05	18	6	0.4
81	L7SCP1H3	210	<2	0.55	<4	26	16	0.05	18	6	0.3
82	L7SCP2H1	270	<2	0.55	<4	24	16	0.04	20	5	0.4
83	L7SCP2H2	260	<2	0.53	<4	27	18	0.05	18	6	0.4
84	L7SCP2H3	230	<2	0.59	<4	27	17	0.05	18	6	0.4
85	L7SRP1H1	300	<2	0.87	5	25	21	0.06	20	7	0.5
86	L7SRP1H2	250	<2	0.75	6	27	24	0.05	21	9	0.5
87	L7SRP1H3	240	<2	0.98	7	24	22	0.06	20	8	0.4
88	L7SRP2H1	270	<2	0.86	<4	26	20	0.06	20	7	0.6
89	L7SRP2H2	270	<2	0.84	7	26	22	0.05	19	7	0.5
90	L7SRP2H3	250	<2	0.85	<4	27	22	0.06	21	8	0.4
91	L8SCP1H1	260	2	0.68	<4	25	25	0.06	18	7	1.2
92	L8SCP1H2	220	3	0.69	<4	26	31	0.06	18	8	2.4
93	L8SCP1H3	200	6	0.83	<4	25	32	0.07	17	7	3.1
94	L8SCP2P1	240	2	0.72	<4	23	24	0.06	18	7	1.2
95	L8SCP2H2	200	5	0.81	7	25	33	0.07	16	8	3.8
96	L8SCP2H3	190	5	0.70	6	26	29	0.06	11	7	3.0
97	L8SRP1H1	200	4	0.80	<4	25	27	0.05	17	7	1.5
98	L8SRP1H2	180	6	0.87	<4	28	35	0.06	19	8	4.0
99	L8SRP1H3	160	7	0.71	<4	26	34	0.06	10	7	2.2
100	L8SRP2H1	190	3	0.74	<4	25	26	0.05	16	7	1.4
101	L8SRP2H2	190	4	0.74	<4	24	32	0.06	18	7	2.5
102	L8SRP2H3	210	8	0.84	<4	27	39	0.08	17	8	4.5

Table A.--Listing of analytical data for samples from three horizons of agricultural soils collected from irrigated land at the Kendrick Reclamation Project Area (continued).

	Sample ID	Sr, ppm	Th, ppm	Ti, %	V, ppm	Y, ppm	Yb, ppm	Zn, ppm
1	L1SCP1H1	210	9	0.18	48	13	1	40
2	L1SCP1H2	230	11	0.18	49	13	2	33
3	L1SCP1H3	230	31	0.15	43	15	1	23
4	L1SCP2H1	190	13	0.16	43	13	1	34
5	L1SCP2H2	230	16	0.19	53	14	2	35
6	L1SCP2H3	280	14	0.16	49	12	1	31
7	R1SCP2H3	280	9	0.18	46	12	1	27
8	L1SRP1H1	200	11	0.23	67	18	2	57
9	L1SRP1H2	200	9	0.14	32	14	1	23
10	L1SRP1H3	210	9	0.16	36	17	2	28
11	L1SRP2H1	240	12	0.21	50	19	2	42
12	L1SRP2H2	190	11	0.13	29	13	2	22
13	L1SRP2H3	200	17	0.16	30	18	2	23
14	L2SCP1H1	210	9	0.17	55	13	1	40
15	L2SCP1H2	220	11	0.20	68	15	2	49
16	L2SCP1H3	230	12	0.23	74	16	2	50
17	L2SCP2H1	190	10	0.21	67	15	1	52
18	L2SCP2H2	200	10	0.21	77	15	2	53
19	L2SCP2H3	240	11	0.23	79	16	2	52
20	L2SRP1H1	79	8	0.18	49	14	2	49
21	R2SRP1H1	78	9	0.18	48	14	2	49
22	L2SRP1H2	91	9	0.20	53	15	2	55
23	L2SRP1H3	97	8	0.19	52	14	2	53
24	L2SRP2H1	84	9	0.18	52	14	2	55
25	L2SRP2H2	120	8	0.18	50	14	2	48
26	L2SRP2H3	140	9	0.19	56	15	2	55
27	L3SCP1H1	150	10	0.18	53	18	2	47
28	L3SCP1H2	170	17	0.17	51	17	2	44
29	L3SCP1H3	180	10	0.21	56	22	3	49
30	L3SCP2H1	120	9	0.17	53	16	2	47
31	L3SCP2H2	130	10	0.16	43	18	2	37
32	R3SCP2H2	130	8	0.15	43	16	2	37
33	L3SCP2H3	170	8	0.16	42	16	2	37
34	L3SRP1H1	120	12	0.20	89	14	2	61
35	L3SRP1H2	160	9	0.24	140	16	2	94
36	L3SRP1H3	150	10	0.30	150	17	2	110
37	L3SRP2H1	130	10	0.22	120	15	2	80
38	L3SRP2H2	170	9	0.30	160	18	2	100
39	L3SRP2H3	160	11	0.30	160	19	2	100

Table A.--Listing of analytical data for samples from three horizons of agricultural soils collected from irrigated land at the Kendrick Reclamation Project Area (continued).

	Sample ID	Sr, ppm	Th, ppm	Ti, %	V, ppm	Y, ppm	Yb, ppm	Zn, ppm
40	L4SCP1H1	130	10	0.17	74	13	2	45
41	L4SCP1H2	170	9	0.28	160	16	2	89
42	L4SCP1H3	170	8	0.29	170	17	2	97
43	L4SCP2H1	130	11	0.18	80	14	2	49
44	L4SCP2H2	130	8	0.13	53	10	1	30
45	L4SCP2H3	130	7	0.15	74	11	1	47
46	L4SRP1H1	160	10	0.20	78	15	2	53
47	L4SRP1H2	190	10	0.19	75	16	2	53
48	L4SRP1H3	190	11	0.22	76	16	2	51
49	L4SRP2H1	170	13	0.27	120	20	2	79
50	L4SRP2H2	190	11	0.24	100	18	2	68
51	R4SRP2H2	190	13	0.25	100	18	2	70
52	L4SRP2H3	190	13	0.22	96	17	2	64
53	L5SCP1H1	160	9	0.16	54	16	2	46
54	L5SCP1H2	160	11	0.15	45	15	2	38
55	L5SCP1H3	160	9	0.15	44	14	2	35
56	L5SCP2H1	180	12	0.21	65	20	2	57
57	L5SCP2H2	180	12	0.20	65	19	2	56
58	L5SCP2H3	160	9	0.16	45	15	2	36
59	L5SRP1H1	150	11	0.18	52	15	2	45
60	L5SRP1H2	150	10	0.20	62	16	2	50
61	L5SRP1H3	140	8	0.16	46	13	1	42
62	L5SRP2H1	160	10	0.18	56	16	2	50
63	L5SRP2H2	170	13	0.22	68	20	2	64
64	L5SRP2H3	180	11	0.21	66	19	2	60
65	L6SCP1H1	120	9	0.16	65	13	1	44
66	L6SCP1H2	110	5	0.09	41	8	<1	26
67	L6SCP1H3	160	12	0.13	48	11	1	28
68	L6SCP2H1	130	6	0.13	42	11	1	32
69	L6SCP2H2	160	9	0.15	70	14	2	41
70	L6SCP2H3	190	9	0.13	55	11	1	30
71	R6SCP2H3	160	6	0.10	49	9	1	24
72	L6SRP1H1	110	7	0.12	42	9	<1	26
73	L6SRP1H2	120	5	0.08	26	7	<1	15
74	L6SRP1H3	140	8	0.08	30	7	<1	15
75	L6SRP2H1	120	6	0.12	40	9	1	27
76	R6SRP2H1	120	8	0.14	48	11	1	33
77	L6SRP2H2	110	8	0.09	37	8	1	20
78	L6SRP2H3	130	8	0.10	35	9	1	18

Table A.--Listing of analytical data for samples from three horizons of agricultural soils collected from irrigated land at the Kendrick Reclamation Project Area (continued).

	Sample ID	Sr, ppm	Th, ppm	Ti, %	V, ppm	Y, ppm	Yb, ppm	Zn, ppm
79	L7SCP1H1	130	12	0.23	85	17	2	68
80	L7SCP1H2	140	10	0.21	89	17	2	63
81	L7SCP1H3	150	11	0.21	76	16	2	55
82	L7SCP2H1	110	9	0.21	74	15	2	57
83	L7SCP2H2	130	12	0.23	86	17	2	63
84	L7SCP2H3	150	10	0.20	77	17	2	55
85	L7SRP1H1	130	9	0.23	130	14	2	75
86	L7SRP1H2	130	10	0.27	160	16	2	90
87	L7SRP1H3	150	10	0.23	130	15	2	75
88	L7SRP2H1	130	11	0.21	120	14	2	69
89	L7SRP2H2	130	11	0.22	120	16	2	73
90	L7SRP2H3	140	12	0.24	120	15	2	70
91	L8SCP1H1	170	9	0.20	150	16	2	79
92	L8SCP1H2	250	8	0.21	190	16	2	83
93	L8SCP1H3	290	8	0.21	190	15	2	84
94	L8SCP2P1	170	8	0.20	150	15	2	76
95	L8SCP2H2	260	9	0.22	200	17	2	88
96	L8SCP2H3	340	6	0.20	190	15	2	81
97	L8SRP1H1	180	9	0.19	170	15	2	74
98	L8SRP1H2	260	7	0.22	220	16	2	92
99	L8SRP1H3	350	7	0.21	210	14	2	86
100	L8SRP2H1	180	8	0.20	170	15	2	75
101	L8SRP2H2	240	7	0.21	190	15	2	85
102	L8SRP2H3	280	8	0.25	230	17	2	100