U.S. DEPARTMENT OF THE INTERIOR

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INTERPRETATION OF RECONNAISSANCE GEOCHEMICAL DATA FROM THE BUREAU OF LAND MANAGEMENT'S WINNEMUCCA DISTRICT AND SURPRISE RESOURCE AREA, NORTHWEST NEVADA AND NORTHEAST CALIFORNIA

By

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This report is preliminary and has not been reviewed for conformity with U.S. Geological Survey editorial standards and stratigraphic nomenclature. Any use of trade names is for descriptive purposes only and does not imply endorsement by the USGS.

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Reconnaissance geochemical data used in this study are from the reanalysis by the U.S. Geological Survey of 3,551 stream-sediment and soil samples collected in the area of the Winnemucca District and Surprise Resource Area during the National Uranium Resource Evaluation (NURE) program, combined with data for 321 stream-sediment samples collected in the area by the USGS in 1993. The area includes a total of 13.5 million acres in northwest Nevada and northeast Caliifornia and is referred to herein as the Winnemucca-Surprise Resource Assessment Area (WSRAA). The analyses included 40-element, and 10-element methods of inductively coupled plasma-atomic emission spectrometry (ICP-AES), and Au by atomic absorption (AA), with graphite furnace. Data from a number of other studies in the area of the WSRAA were consulted and used in the interpretation, including data for 1,904 stream-sediment samples from a study by Barringer Resources, Inc., of BLM wilderness study areas within the Winnemucca District.

The results of this study indicate the presence of a large number of geochemical anomalies in the area of the WSRAA. Most of the anomalies are in the areas of mining districts, and probably relate to known mineral deposits of the districts, but may also in part reflect contamination from mined deposits. The relationship of the anomalies to the mining districts is evident on geochemical maps included in this report. These maps show the distribution and abundance of antimony, arsenic, barium, copper, gold, lead, lithium, molybdenum, silver, and zinc, and the locations of 96 mining districts. Many of the anomalies are, however, not apparently related to mining districts. Some of the more prominent of these anomalies are encircled on the maps and discussed individually. Some of these areas contain known mineral deposits and are areas of recent mineral exploration. The distribution of geochemical anomalies suggests areas for further exploration.

Factor analysis was used to aid in defining multi-element suites. An 8-factor model was selected and maps of varimax factor scores for these factors, which show lithologic and mineralization associations, are included in this report. The plot of factor scores for one of the factors (factor 1), although largely a lithologic factor, may be useful in exploration for iron or massive sulfide deposits. A mineralization factor (factor 3) shows high factor scores in many of the mining districts. Elsewhere, high factor scores for this factor suggest areas for mineral exploration.

INTRODUCTION

The U.S. Geological Survey (USGS) is a party to joint interagency Memorandum of Understandings (MOUs) with the Bureau of Land Management (BLM) and the U.S. Bureau of Mines (USBM) to coordinate resource assessments and evaluations of BLM administered lands. Resource assessments of BLM Resource Areas, that are conducted by the USGS under these MOUs, assist the BLM in meeting inventory and evaluation, resource-management planning, and other management requirements of the Federal Land Policy and Management Act of 1976 (FLPMA). This report is one of several to be generated as part of a resource assessment of BLM-administered lands in northwest Nevada and northeast California (figs. 1, 2).

The project area is composed of three contiguous BLM Resource Areas (RAs), totalling 13.5 million acres, in northwest Nevada and northeast California (figs. 1, 2). The Sonoma-Gerlach and Paradise-Denio Resource Areas in northwest Nevada together comprise the BLM's Winnemucca District. The Surprise RA is located in extreme northwest Nevada and northeast California and is part of the BLM's Susanville District, which is administered by the BLM's California state office. Henceforth in this report, the project area will be referred to as the Winnemucca-Surprise Resource Assessment Area (WSRAA).

Other reports on the WSRAA include the following. A report on geology, and its relation to resource genesis (Doebrich, 1996) has been released as an U.S. Geological Survey Open-File Report. A report on metallic mineral resources in the WSRAA, to be released as an open-file report, is in press (Peters and others, 1996).

The present report presents an interpretation of the distribution and associations of trace-element data from reconnaissance geochemical samples from the WSRAA. Geochemical maps showing the distribution and abundance of 10 selected elements, including gold, silver, arsenic, antimony, copper, lead, molybdenum, zinc, barium, and lithium, are included in this report. These maps also show the approximate locations of mining districts in and adjacent to the WSRAA. For a discussion of the geology of the WSRAA the reader is referred to the report by Doebrich (1996).

SOURCES OF GEOCHEMICAL DATA

The chief source of geochemical data used in this study is from the reanalysis by the USGS of 3,551 stream-sediment and soil samples collected in, and adjacent to, the WSRAA as part of the National Uranium Resource Evaluation (NURE) program. In 1993, as part of this study, and to supplement the NURE samples, 351 stream-sediment samples were collected by the USGS in the area of the WSRAA, analyzed, and the data merged with the data from the reanalyzed NURE samples. Many of these samples were collected in the California portion of the WSRAA where NURE sampling had not been done. Other data used in this study include data from the original analyses of the NURE samples (Hoffman and Buttleman, 1994), and data for 1,904 stream-sediment samples from a study by Barringer Resources, Inc. (1982) of BLM Wilderness Study Areas (WSAs) in the Winnemucca District. Other sources of geochemical data are from USGS and USBM studies of BLM and Forest Service WSAs. This includes data from a mineral resources study of the Charles Sheldon WSA (Cathrall and others, 1977). Geochemical data from a mineral resources study of the South Warner

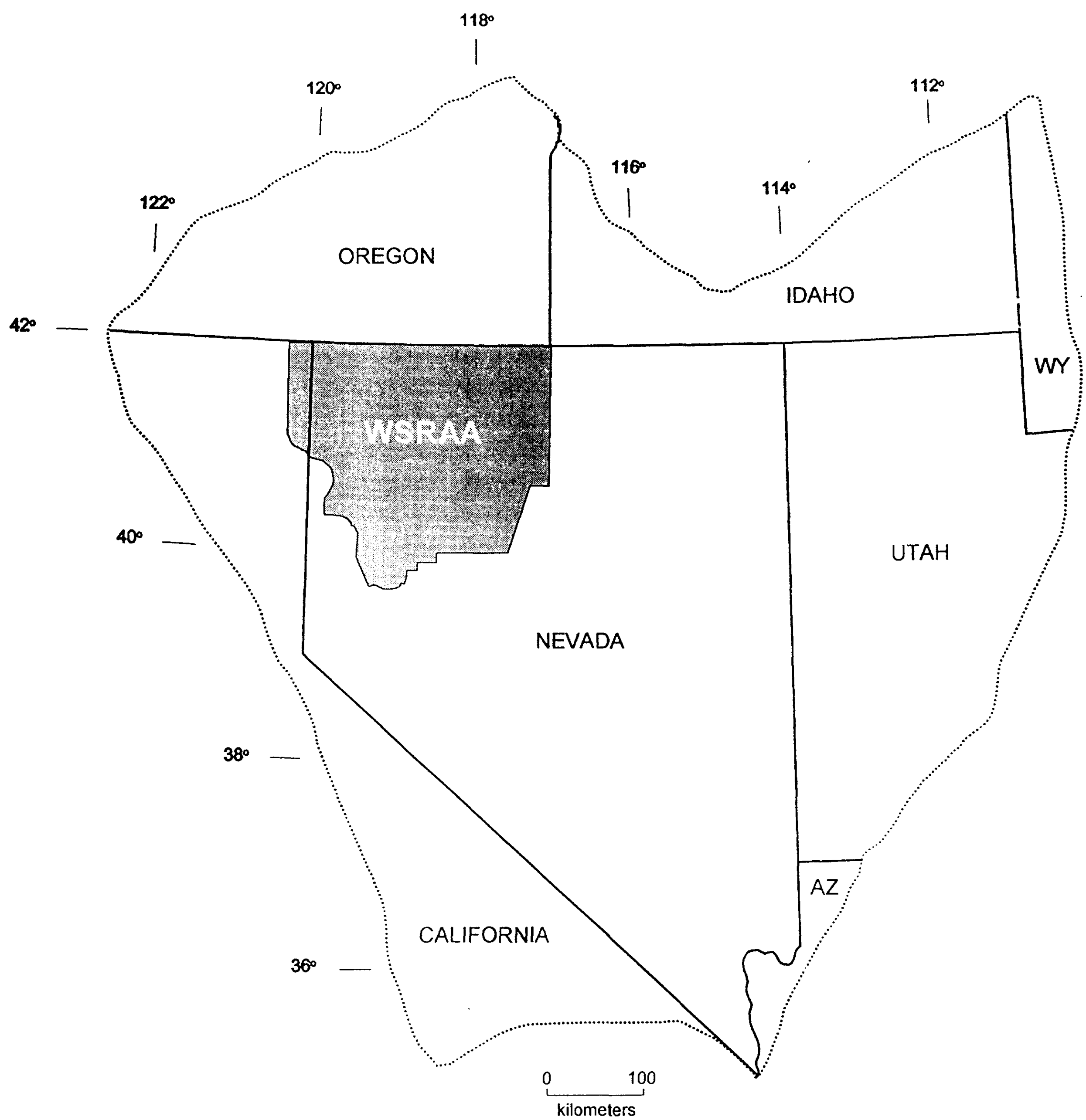


Figure 1. Index map of Great Basin showing location of Winnemucca-Surprise Resource Assessment Area (WSRAA).

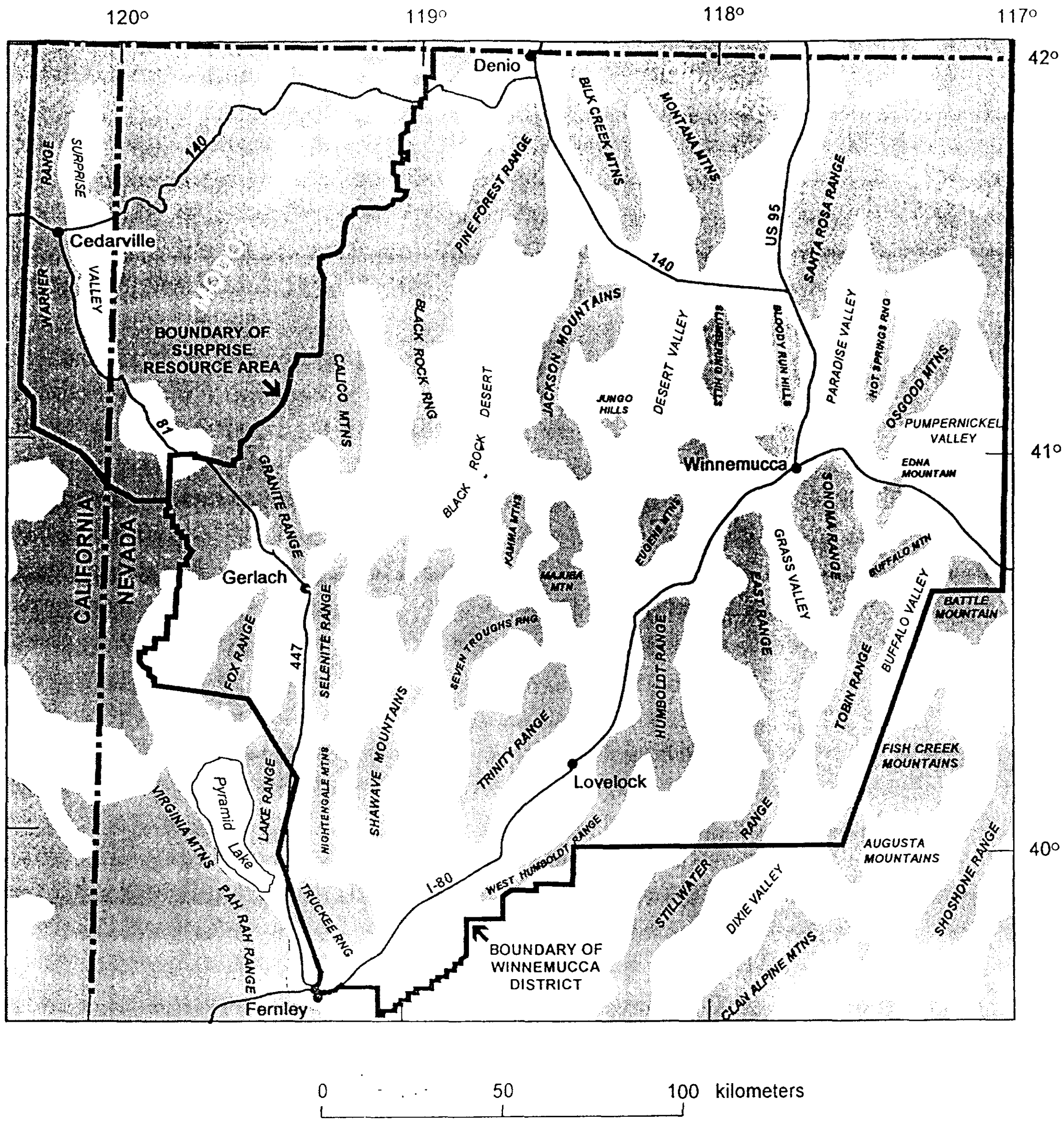


Figure 2. Map of the Winnemucca-Surprise Resource Assessment Area showing locations of selected geographic and cultural features and state and Bureau of Land Management boundaries. Shaded areas represent ranges and areas of exposed rock. White areas represent alluvium-covered basins.

Wilderness, Modoc County, California (Duffield and others, 1976) had not been entered into the U.S. Geological Survey's computerized analytical data storage system (RASS) and was not available in digital form. The data was, however, inspected on the analyst's original report sheets.

NURE stream-sediment samples from the Reno 1° x 2° quadrangle had previously been reanalyzed by the USGS as part of a geology and mineral resources study of that quadrangle (John and others, 1993; Kilburn and others, 1990). Splits of the NURE samples from the Reno quadrangle in, and adjacent to, the WSRAA were reanalyzed again for the present study because different analytical methods were used for the Reno quadrangle study.

Nure sampling during the NURE program was done within the area of the WSRAA from 1978-1980 on a 1° x 2° quadrangle basis under the responsibility of two Department of Energy (DOE) national laboratories: Lawrence Livermore Laboratory (LLL), and Savannah River Laboratory (SRL). LLL was responsible for the Lovelock (Qualheim, 1979), and Winnemucca (Puchlik, 1978) quadrangles, and SRL was responsible for the McDermitt (Thayer and Cook, 1980), Reno (Bennett, 1980), and Vya (Cook, 1981) quadrangles. The actual sampling was done by contract personnel. LLL sampling methods are described in Puchlik (1977) and in Leach (1977). For the arid to semi-arid region of the WSRAA, LLL emphasised sampling along range fronts, with additional sites within the canyons of larger drainages. In valleys, dry sediments were to be collected only along major, well-defined drainages. SRL sampling methods are described in Price and Jones (1979), and in Cook and Fay (1982). The SRL sampling plan was on a grid system, and the site was to be selected as near the center of each grid unit as practical. Supplemental samples were to be collected as deemed desirable by the sampler, based on criteria given in Price and Jones (1979). Both stream-sediment and soil samples were collected in the three quadrangles sampled by SRL in the WSRAA.

The NURE samples have been archived by the USGS in Denver, CO, since 1985. Samples from the area of the WSRAA were obtained from warehouse storage and splits taken for analysis. The splits were sieved, when necessary, to pass an 80-mesh (0.18-mm) sieve and the finer fraction saved for analysis. The USGS samples collected in 1993 were also sieved to <80 mesh.

The methods used for the reanalysis of the NURE samples and for the analysis of the 321 USGS samples collected in 1993 are as follows. The samples were analyzed for 40 elements by inductively coupled plasma-atomic emission spectrometry (ICP-AES)(Briggs, 1990). The samples were also analyzed by a 10-element ICP-AES method (Motooka, 1990) to obtain lower limits of determination for pathfinder elements. Gold was determined in the samples by atomic absorption spectrophotometry (AA) with graphite furnace (O'Leary, and Meier, 1990), providing a lower limit of determination of 0.002 parts per million (ppm). The analyses did not include mercury or tungsten, and a high lower limit of determination for uranium (100 parts per million, ppm, by the 40-element ICP-AES method) provided only one value for only one sample (140 ppm); all other values were reported as less than 100 ppm. The elements analyzed, along with a statistical summary of the analytical data, are presented in table 1 (p. 6). Analytical data for the reanalyzed NURE samples and for the 351 USGS samples were reported by King and others (1996).

Analytical data for NURE and USGS samples, hereinafter to be referred to simply as NURE data, were entered into the USGS's computer data base, retrieved, and processed, using the STATPAC program (VanTrump and Miesch, 1977).

Table 1. Statistical summary of analytical data for NURE and USGS stream-sediment and soil samples from the Winnemucca-Surprise Resource Assessment Area, northwest Nevada and northeast California

[Data are expressed in parts per million except for Al, Ca, Fe, K, Mg, Na, P, and Ti, which are in percent. Min, minimum; Max, maximum; A.M., arithmetic mean, S D , standard deviation; G.M., geometric mean; G.D., geometric deviation, Valid, unqualified or number of samples not qualified by B, L, N, or G; dashes (--) denote no data; B, no analysis; L, looked for but not detected at the lower limit of determination; N, not detected; G, an undetermined amount greater than the upper limit of determination; DR, detection ratio; ICP-40, 40-element method of inductively coupled plasma-atomic emission spectrometry (ICP-AES); ICP-10, 10-element method of ICP-AES; AA, atomic absorption spectrophotometry with heated graphite atomizer]

Element	Method	Min	Max	A.M.	S.D.	G.M.	G.D.	Valid	B	L	N	G	DR[1]
Al	ICP-40	.69	15	7.69	1.17	7.64	1.23	3870	2	0	0	0	1
Ca	ICP-40	.2	38	3.18	2 68	2.49	1.94	3870	2	0	0	0	1
Fe	ICP-40	.21	31	3.87	2.17	3.39	1.65	3870	2	0	0	0	1
K	ICP-40	.17	5.1	2.04	0.60	1.85	1.38	3870	2	0	0	0	1
Mg	ICP-40	.12	7.1	1.07	0.57	0.93	1.72	3870	2	0	0	0	1
Na	ICP-40	.10	7.5	2.01	0.70	1.78	1.50	3870	2	0	0	0	1
P	ICP-40	.008	.45	0.092	0.04	0.08	1.55	3870	2	0	0	0	1
Ti	ICP-40	.03	4 5	0.48	0.32	0.41	1.75	3870	2	0	0	0	1
Mn	ICP-40	130	9200	1015	538	907	1.62	3870	2	0	0	0	1
Ag	ICP-40	2	49	2.03	0.87	6 57	2.35	17	2	3853	0	0	.00
As	ICP-40	10	330	17.7	22.4	19.6	1.98	1755	2	2115	0	0	.45
Au	ICP-40	--	--	--	--	--	--	0	2	3870	0	0	--
Ba	ICP-40	26	6900	907	448	833	1.58	3870	2	0	0	0	1
Be	ICP-40	1	23	2.00	0.88	1.90	1.44	3819	2	51	0	0	.99
Bi	ICP-40	10	24	10	0.28	--	--	4	2	3866	0	0	.00
Cd	ICP-40	2	130	2.09	2.31	3 49	2.05	97	2	3773	0	0	.03
Ce	ICP-40	4	660	64.2	26	61 7	1.45	3870	2	0	0	0	1
Co	ICP-40	2	210	17	10.9	14 3	1.73	3870	2	0	0	0	1
Cr	ICP-40	1	600	52.5	45.6	39 2	2.21	3866	2	4	0	0	1
Cu	ICP-40	3	3800	31.6	76.4	23.2	1.94	3870	2	0	0	0	1
Eu	ICP-40	2	4	2.0	0.07	2.34	1.26	39	2	3831	0	0	.01
Ga	ICP-40	4	64	19.2	3.4	18 5	1.19	3870	2	0	0	0	1
Ho	ICP-40	--	--	--	--	--	--	0	2	3870	0	0	--
La	ICP-40	4	350	33.6	13.2	30.7	1.48	3870	2	0	0	0	1
Li	ICP-40	6	910	33.0	28.3	28.2	1.69	3870	2	0	0	0	1
Mo	ICP-40	2	42	2.22	1.83	6.16	2.08	139	2	3731	0	0	.04
Nb	ICP-40	4	120	15 2	5.36	14.3	1.38	3859	2	11	0	0	1
Nd	ICP-40	4	300	29.1	11.2	26.4	1.44	3865	2	5	0	0	1
Ni	ICP-40	2	460	24 6	22.4	18.8	2.03	3860	2	10	0	0	1
Pb	ICP-40	4	2200	20.3	40.6	16.9	1.59	3813	2	57	0	0	.99
Sc	ICP-40	2	67	11 8	5.45	10.6	1.53	3865	2	5	0	0	1
Sn	ICP-40	5	95	5.08	2.01	12.1	2.33	23	2	3847	0	0	.01
Sr	ICP-40	29	6200	415	251	364	1.74	3870	2	0	0	0	1
Ta	ICP-40	--	--	--	--	--	--	0	2	3870	0	0	--
Th	ICP-40	4	170	10.3	7 80	9.44	1.51	3670	2	200	0	0	95
U	ICP-40	--	--	--	--	--	--	1	2	3869	0	0	00
V	ICP-40	6	1400	124	97 3	101	1.84	3870	2	0	0	0	1
Y	ICP-40	2	96	23 5	9 94	21	1 48	3869	2	1	0	0	1
Yb	ICP-40	1	12	2.42	1.26	2.27	1.62	3720	2	150	0	0	.96
Zn	ICP-40	5	14000	97 7	262	84.5	1.53	3870	2.	0	0	0	1
Ag	ICP-10	.067	46	0 13	0 87	0.15	2.53	691	4	0	3177	0	.18
As	ICP-10	.67	360	11 2	21.4	5 93	3.04	3487	1	0	384	0	90
Au	ICP-10	.1	1 9	0 103	0 061	0 34	3.02	9	1	0	3862	0	.00
Bi	ICP-10	.67	28	1 04	0 71	2 21	2 03	49	1	0	3822	0	01
Cd	ICP-10	.05	120	0.38	2.22	0.23	2.31	3537	1	0	334	0	.91
Cu	ICP-10	.02	3900	25.6	75.1	18.2	2.03	3870	1	0	1	0	1
Mo	ICP-10	.08	42	1.25	2.34	0 82	2.19	3852	1	0	19	0	1
Pb	ICP-10	1	2300	12 6	42.1	9.14	1.93	3867	1	0	4	0	1
Sb	ICP-10	.67	160	2.34	6.97	2.53	2.43	1426	1	0	2445	0	.37
Zn	ICP-10.	.05	14000	72	256	58.7	1.70	3869	1	0	1	1	1
Au	AA	002	4.4	0 005	0 076	0 005	2.95	510	10	3352	0	0	.13

[1]Detection ratio (DR) is the number of uncensored values divided by the total number of samples analyzed for a given element.

Barringer Resources, Inc., methods of analysis used in the study of WSAs in the Winnemucca District are briefly noted here because Barringer data was combined with NURE data for geochemical maps for several elements. Atomic absorption spectrometric (AA) methods were used for Au, Ba, and Sb. As was analyzed by a colorimetric method using a Spectronic 21 spectrophotometer. The method used for Li was not reported. Details of the Barringer methods are given in Barringer Resources, Inc. (1982, vol. IV, appendix C). Table 2 (p. 8) presents a statistical summary of analytical data for combined NURE, USGS, and Barringer stream-sediment and soil samples.

INTERPRETATION OF GEOCHEMICAL DATA

Interpretation of the results of this study indicate the presence of a large number of geochemical anomalies in the area of the WSRAA. Determination of what analytical values are anomalous was based, in large part, on examination of histograms and geochemical maps. Generally, relatively higher values are clustered in areas of mining districts, where the element is a commodity, and are considered to be anomalous. Anomalous values are indicated on the histograms for As, Sb, Au, Ag, Cu, Pb, Mo, and Zn (figs. 3-10). Because of the size of the WSRAA, with highly diverse geology and diverse mineral deposit types, meaningful exact threshold values for the entire area cannot be established, and the lower values shown on the histograms as anomalous should be considered only as a general guide.

The NURE and Barringer data were combined in preparing the geochemical maps for As, Au, Ba, Li, and SB. Only NURE data were used for the maps for Ag, Cu, Mo, Pb, and Zn. Histograms and statistics for NURE and Barringer data were examined in determining which element data might be satisfactorily combined for the maps.

A geochemical map for U was prepared using original NURE data (Hoffman and Buttleman, 1994), combined with Barringer data. This map (not included in this report) was examined in determining areas of anomalous concentrations of U in the WSRAA.

All reported values of Au were considered to be anomalous. Au determined by atomic absorption was reported in 525 samples with values ranging from 0.002 to 4.4 ppm. Anomalous values of Au were found in samples from, or adjacent to, all except five of the 73 mining districts in the WSRAA where Au is a commodity, as well as in several other districts. This suggests that Au is a good pathfinder element for its own deposits in this area. Anomalous values of Au were also found in areas where the values may not be attributable to the mining districts. The more notable of these areas are encircled on the geochemical maps and discussed in the section "Geochemical anomalies not related to mining districts." As and Sb are commonly associated with Au in gold deposits in the WSRAA, as previously reported (McGuire and Albino, 1994; Doebrich and others, 1994), and are therefore useful elements for gold exploration, and also for indicating their own deposits, and deposits of other metals.

Examination of preliminary plots of elements that are commodities in the WSRAA and associated elements indicated that most higher values of these elements plotted in areas of known mineral deposits, chiefly the mining districts. In an attempt to show subtle geochemical anomalies, or anomalies relating to concealed, unknown mineral deposits, the geochemical maps were prepared showing all analytical values. The values are shown on the maps as ranges of values, based on percentiles, and represented by various symbols.

Table 2. Statistical summary of analytical data for combined NURE, USGS, and Barringer stream-sediment and soil samples from the Winnemucca-Surprise Resource Assessment Area, northwest Nevada and northeast Callifornia

[Data are expressed in parts per million. B.R., Barringer Resources, Inc., Min, minimum; Max, maximum; A.M., arithmetic mean; S.D., standard deviation; G.M., geometric mean; G.D., geometric deviation; Valid, unqualified, or number of samples not qualified by B, L, or N; B, no analysis; L, looked for but not detected at the lower limit of determination; N, not detected; AA, atomic-absorption spectrophotometry; ICP-10, 10-element method of inductively coupled plasma-atomic emission spectrometry, ICP-AES; Color, colorimetric]

Element	Method		Min	Max	A.M.	S.D.	G.M.	G.D	Valid	B	L	N
	USGS	B.R.										
Au	AA	AA	.002	4.4	.004	062	.005	2.96	525	10	3352	1889
As	ICP-10	Color	.67	360	10.8	18.6	6.73	2.77	5130	1	0	645
Sb	ICP-10	AA	.67	160	1.92	5.82	2.55	2.44	1452	1	0	4323
Ba	ICP-40	AA	12.4	6900	915	437	846	1.55	5774	2	0	0
Li	ICP-40	--[1]	1	910	29.9	24.2	25.7	1.65	5774	2	0	0

[1] method not reported

GEOCHEMICAL ANOMALIES

Geochemical anomalies related to mining districts

Most of the geochemical anomalies are composed of multiple elements and are apparently related to mining districts. Table 3 lists names and commodities of the districts, and elements determined from this study to have anomalous concentrations in samples collected in the area of the mining districts. The names of the districts and the commodities in the Nevada part of the WSRAA are from Tingley (1992, plate 1), and the commodities are given in the same order in table 3 as presented by Tingley. Table 3 also lists the only mining district, the High Grade district, and its one commodity, gold (Hill, 1915; Clark, 1970) in the California portion of the WSRAA. Single-element geochemical maps showing the distribution and abundance of gold, silver, arsenic, antimony, copper, lead, molybdenum, zinc, barium, and lithium were selected for inclusion in this report (plates 1-10, in pocket). All of these elements are commodities in the WSRAA, with the exception of barium, in which case the sulfate of barium, barite, is the commodity. The maps show the approximate boundaries of the mining districts, as shown by Tingley (1992, plate 1) and by Clark (1970, plate 1). The mining districts are identified on the maps by numbers which correspond to numbers in table 3. A column with the heading "Block" is included in table 3 to aid in locating the mining districts. In this column are listed the coordinates at the southeast corner of a block, or rectangular area, in which the district is located. For example, the block "40,118" includes the area from 40°-41° latitude, and 118°-119° longitude. The blocks or their outlines are not actually shown on the maps.

Anomalous metal values detected in stream-sediment samples collected in the areas of mining districts are from the weathering and erosion of mineralized rock within the drainage area upstream from the sample site. The samples may also be in part enriched in metals as a result of mining activities and ore processing, and erosion of mine dumps in the upstream area.

Geochemical anomalies not apparently related to mining districts

A number of geochemical anomalies were determined to occur in the WSRAA which do not appear to be related to the mining districts. Most of the more prominent of these anomalies are encircled and are identified on the maps by letters corresponding to those in table 4, which lists elements found in anomalous concentrations in the areas. Names of topographic features in the area of each anomaly are informaly given to aid in locating the areas. To further aid in locating these areas, table 4 includes a column with the heading "Block"; this column is explained for table 3, above. These anomalies are discussed below.

Area A

Area A, located in the northwest part of the WSRAA, about 20 miles southeast of Vya, is anomalous in As, Au, Ba, Be, Cd, Mo, and Sb. Mineral resources studies have been done in this area, in the High Rock Canyon WSA (Turrin and others, 1988; Scott, 1987) and in the East Fork High Rock Canyon WSA (Ach and others, 1987; Schmauch, 1986). This area

Table 3.— Mining districts, commodities, and associated geochemical anomalies in the Winnemucca-Surprise Resource Assessment Area

[Mining district names and commodities are from Tingley (1992). Geochemical anomalies are based on results of this study.]

MAP NO	MINING DISTRICT	BLOCK	COMMODITIES	GEOCHEMICAL ANOMALIES
1	Antelope	40,118	Ag, Pb, Cu, Sn, Au, Zn, Hg, W, Mo, As, Sb, U	Ag, As, Au, Cu, Pb, Sb, Zn
2	Antelope Springs	40,118	Au, Hg, Sb, Ag, W, Cu, Pb	Ag, As, Au, Mo, Pb, Sb
3	Arabia	40,118	Pb, Ag, Sb, Zn Au, Cu, As	Ag, As, Au, Sb
4	Awakening	41,117	Au, Ag, Pb, Cu, W	Ag, As, Au, Bi, Mo, Sb
5	Battle Mountain	40,117	Cu, Au, Ag, Sb, Pb, Zn, W, Mo, As, Ni	Ag, As, Au, Ba, Bi, Cd, Cu Mo, Pb, Sb, Zn
6	Black Diablo	40,117	Mn	Au, As, Cu, Pb, Sb, Zn
7	Black Knob	40,118	Sb, Hg	Ag, As, Au, Mo, Pb, Sb, Zn
8	Black Rock	41,119	Ag, Au, U	As, Au, Ba, Mo, Sb, U, Zn
9	Blue Wing	40,119	Au, Ag, W	As, Au, Sb
10	Bottle Creek	41,118	Hg	Ag, As, Au, Cu, Mo, Pb, Sb, Zn
11	Buena Vista	40,118	As, Au, Pb, W, Zn, Cu, Sb	Ag, As, Au, Mo, Pb, Sb, Zn
12	Buffalo Mountain	40,117	Au, Mn, Cu, Ag	Ag, As, Au, Ba, Bi, Cu, Mo, Pb, Sb, Zn
13	Buffalo Valley	40,117	Au, Cu, Mn, Ag, Pb, Zn	Ag, As, Au, Ba, Bi, Cu, Mo, Pb, Sb, Zn
14	Copper Valley	40,118	W, Cu, Fe	As, Cu, Mo, Sb
15	Cottonwood	40,119	Ag, Pb, Cu, Au, W, Sb	Ag, As, Au, Ba, Cu, Mo, Pb, Sb, Zn
16	Deephole	40,119	Au, Ag, Cu, Pb, W, Ti	Ag, Cu, U, Zn
17	Desert	39,118	Au, Ag, Hg	Ag, As, Au, Zn
18	Disaster	41,118	Au, Ag, U, Li	Ag, As, Au, Cu, Mo, Pb, Sb, U, Zn
19	Donnelly	41,119	Au, Ag	Ag, As, Au, Ba, Cu, Zn
20	Dutch Flat	41,117	Au, Ag, Hg, W, Cu, Pb	Ag, As, Au, Sb
21	Dyke	41,118	Ag, Au, Sb	Ag, As, Au, Cu, Mo, Pb, Sb, U
22	Farrell	40,118	Au, Ag	Ag, As, Au, Mo, Sb
23	Forty-Nine Range	41,119	Ti	Au, Zn
24	Gerlach	40,119	gypsum	As, Au, Mo, Sb
25	Golconda	40,117	W, Mn, Cu, Au, Pb, Zn, iron, barite, Be	Ag, As, Au, Ba, Bi, Cu, Mo, Pb, Sb, Zn
26	Gold Butte	40,118	Au, Ag, W	Ag, As, Au, Cd, Mo, Sb, U, Zn
27	Gold Run	40,117	Cu, Au, Ag, Pb, Zn, W, Mo, Ni	Ag, As, Au, Cu, Mo, Pb, Sb, Zn
28	Goldbanks	40,117	Hg, Au, Ag, Sb	Ag, As, Au, Ba, Cu, Mo, Pb, Sb, Zn
29	Harmony	40,117	Ag, Cu, Au, Hg	Ag, As, Au, Cu, Pb, Sb, Zn
30	Haystack	40,118	Au, Ag, W	Au
31	High Grade	41,120	Au	As, Au, Mo, Zn
32	Hooker	40,119	W, Mo	As, Mo, U
33	Imlay	40,118	Au, Ag, Hg, W, Sb, Be	Ag, As, Au, Cd, Mo, Pb, Sb, Zn
34	Indian	40,118	Ag, Au	Ag, Au, Pb
35	Iron Hat	40,117	Pb, Ag, W, Sb, Cu, Au	Ag, As, Au, Ba, Cd, Cu, Mo, Pb, Sb, Zn
36	Iron Point	40,117	Ag, Mn, Au, Pb, V, Zn	Ag, As, Au, Ba, Mo, Pb, Sb, Zn
37	Jackson Mountains	41,118	Fe, Cu, Pb, Ag, W, Ni, Ti	Ag, As, Au, Cu, Mo, Pb, Sb, U, Zn
38	Jersey	40,117	Ag, Pb, Zn, Cu, Au, Mn	Ag, As, Au, Ba, Cu, Mo, Pb, Sb, U, Zn
39	Jessup	39,118	Au, Ag, W	Ag, As, Au, Mo, Pb, Sb, Zn
40	Jungo	40,118	Au(placer), Hg, Pb, Ag	Ag, As, Au, Ba, Cd, Cu, Mo, Pb, Sb, Zn
41	Juniper Range	40,119	W, Cu, Ag, Au	Au, U, Zn
42	Kennedy	40,117	Ag, Au, Pb, Cu, Zn	Ag, As, Au, Ba, Cd, Cu, Pb, Sb
43	Lake	39,118	Ag, Sb, Pb	Ag, As, Ba, Mo, Sb, Zn
44	Leadville	41,119	Au, Ag, Pb, Cu, Zn	Ag, As, Au, Cu, Ba, Bi, Cd, Hg, Mo, Pb, Sb, Zn
45	Leonard Creek	41,118	Au, W, U	As, Au, Cu, U, Zn
46	Lone Pine	41,119	Hg, Au	Au, Sb, Zn
47	Mill City	40,118	W, Mo, Ag, Cu, Au, Pb, Sb	Ag, As, Au, Bi, Cu, Mo, Pb, Sb, U, Zn
48	Mineral Basin	40,118	Fe, Ag, Sb, Hg	Ag, As, Sb

Table 3. Mining districts, commodities, and associated geochemical anomalies in the Winnemucca-Surprise Resource Assessment Area--Continued

49	Mount Tobin	40,117	Hg, Sb	Ag, As, Au, Ba, Cu, Mo, Pb, Sb, Zn
50	Muttlebury	40,118	Ag, Pb, Sb, Cu, Au	Ag, As, Au, Cd, Cu, Mo, Sb, Zn
51	National	41,117	Au, Ag, Hg, Sb, W, As	Ag, As, Au, Cu, Pb, Sb, Zn
52	Nightingale	40,119	W, Sb, Au, Ag, U	As, Sb
53	Opalite	41,117	Hg	As, Au, Mo, Pb, Sb
54	Paradise Valley	41,117	Ag, Au	Ag, As, Au, Pb, Sb, Zn
55	Placerites	40,118	Au, Cu	Ag, As, Au, Pb, Sb
56	Potosi	41,117	Au, W, Ag, Cu, Mo, As, Sb, Hg, barite	Ag, As, Au, Bi, Cu, Mo, Pb, Sb, Zn
57	Poverty Peak	41,117	Hg	Ag
58	Pueblo	41,118	Au, Ag, Cu, Pb	Cu
59	Rabbit Hole	40,118	Au, W, Ti	Ag, As, Au, Cu, Sb, Zn
60	Ragged Top	40,118	W	As, Mo, Sb
61	Rebel Creek	41,117	Ag, Au	Ag, As, Au, Mo, Pb, Zn
62	Red Butte	41,118	Cu, Ag, Sb, Hg, Pb, Zn	Ag, As, Au, Cu, Mo, Pb, Sb, Zn
63	Rochester	40,118	Ag, Au, Pb, Cu, Zn, Sb, W	Ag, As, Au, Cu, Mo, Pb, Sb, U, Zn
64	Rose Creek	40,117	W, Mn, Be	Ag, As, Au, Mo, Pb, Sb
65	Rosebud	40,118	Ag, Au, Cu, Pb	Ag, As, Pb, Sb
66	Rye Patch	40,118	W, Ag, Be, U, Au, Pb, Cu, Sb	Ag, As, Au, Cd, Mo, Pb, Sb, Zn
67	Sacramento	40,118	Ag, Pb, Au, W, As	Ag, As, Au, Pb, Sb, U, Zn
68	San Emidio	40,119	Au, Ag, Hg	Au
69	San Jacinto	40,118	Ag, Pb, As	As, Au, Bi, Mo, Sb
70	Sawtooth	40,118	Au	As, Au, Mo, Sb, Zn
71	Scossa	40,118	Au, Ag, Ti	Ag, As, Au, Cd, Cu, Mo, Sb, Zn
72	Seven Troughs	40,118	Au, Ag, Pb, Cu, Zn, W, Sb, U, As	Ag, As, Au, Mo, Pb, Sb, U, Zn
73	Sherman	41,117	W, Mo, Au, Ag	
74	Shon	41,117	Ag, W	Ag, As, Au, Mo
75	Sierra	40,117	Au, Ag, Cu, Pb, Zn, W, As	Ag, As, Au, Cu, Pb, Sb, U, Zn
76	Spring Valley	40,118	Au, Ag, Pb, Hg, Cu, Sb	Ag, As, Au, Pb, Sb
77	Staggs	40,118	Ag, Pb, Au, W	Ag, As, Cd, Mo, Pb, Zn
78	Star	40,118	Ag, Pb, Sb, Au, Cu, Zn	Ag, As, Au, Cd, Mo, Pb, Sb, Zn
79	Sulphur	40,118	Au, Ag, Hg	Ag, As, Au, Mo, Sb, Zn
80	Table Mountain	40,117	Cu, Ni, Co, Hg, Ag, Pb, Sb, Au, W, As, Ti	Ag, As, Au, Cu, Pb, Sb, U
81	Ten Mile	40,117	Au, Ag, Cu, Pb, Zn, Sb, W	As, Au, Sb, Zn
82	Tobin and Sonoma Range	40,117	Cu, Hg, W, Mn	Ag, As, Au, Ba, Cd, Cu, Mo, Pb, Sb, Zn
83	Toy	39,118	W, Sb	As, Mo, Sb, Zn
84	Trego	40,119	W, Au, Ag, Cu, Pb	Ag, As, Au, Cu, Mo, Pb, Sb
85	Trident Peak	41,118	Ag, Pb	Au, Cu, Mo, Pb
86	Trinity	40,118	Au, Ag, W, Pb, Zn	Ag, As, Au, Mo, Pb, Sb, Zn
87	Truckee	39,119	Au, Ag, Pb	Ag, As, Au, Cu, Mo, Pb, Sb, Zn
88	Varyville	41,118	Au, Ag, Cu, Pb, W, Sb, Mo	Ag, As, Au, Cu, U
89	Velvet	40,118	Au, Ag	As, Au, Mo, Pb, Sb, U
90	Vicksburg	41,118	Au, W, Ag, Cu, Pb	As, Au, Cu, Mo, U
91	Virgen Valley	41,119	U, Hg, V	As, Ba, Mo, Pb, Sb, U
92	Washiki	40,117	Au, Ag, Pb	Ag, As, Au, Pb, Sb
93	Wild Horse	40,118	W, Sb, Ag, Pb, Fe, As	Ag, As, Au, Ba, Cd, Cu, Mo, Pb, Sb, Zn
94	Willard	40,118	Au, Sb, Ag, Cu	Ag, As, Au, Cd, Mo, Sb, U, Zn
95	Willow Creek	40,117	Au, Ag	Ag, As, Au, Cu, Mo, Pb, Sb, Zn
96	Winnemucca	41,117	Au, Ag, Pb, Cu, Hg	Ag, As, Au, Ba, Cd, Cu, Mo, Pb, Sb, Zn

Table 4. Geochemical anomalies not apparantly related to mining districts in the Winnemucca- Surprise Resource Assessment Area

AREA	LOCATION	BLOCK	GEOCHEMICAL ANOMALIES
A	High Rock Canyon	41,119	As, Au, Ba, Cd, Pb, Mo, Sb, Zn
B	Cottonwood Creek	41,119	Ag, As, Au, Mo, Pb, Sb, Zn
C	South of Hog Ranch Mountain	41,119	Ag, Au, Ba, Bi, Cd, Cu, Mo, Pb, Sb, U, Zn
D	Callico Hills	40,119	Ag, As, Au, Ba, Cd, Mo, Pb, Sb, U, Zn
E	South end Black Rock Range	40,118	Ag, As, Au, Ba, Li, Mo, Pb, Sb, U
F	Gerlach	40,119	Ag, As, Cu, Li, Mo, Pb, Sb, U, Zn
G	Mt Limbo	40,119	As, Mo, U, Zn
H	Sahwave Mountains (north end)	40,119	Ag, As, Au, Li, Mo, Pb, Sb, U, Zn
I	Truckee Range	39,119	Au
J	Black Rock Desert	41,118	Ag, As, Au, Ba, Cu, Li, Mo, Sb, U, Zn
K	King Leer Peek, Jackson Mtns	41,118	Ag, As, Au, Cu, Pb, Sb, Zn
L	Sugarloaf Knob, Jackson Mtns	40,118	Ag, As, Au, Cu, Mo, Pb, Sb, U, Zn
M	Antelope Range	40,118	Ag, As, Au, Cu, Sb, U
P	Silver State Valley	41,117	Ag, Au, Mo, Pb, Sb, U
Q	East Range	40,117	Ag, As, Au, Ba, Cu, Li, Mo, Pb, Sb, Zn
S	Tobin Range	40,117	Ag, As, Au, Ba, Cu, Sb, Zn
T	Augusta Mountains	40,117	As, Au, Ba, Cd, Li, Mo, Pb, Sb, U, Zn

was delineated largely on the basis of the distribution of As values, and extended eastward to include a cluster of high Ba values. The area includes three sites that are anomalous in Au values. The highest Au value was found in a sample from upper High Rock Canyon. Mercury occurs in cinnabar in massive opal and opalized breccia about 2-3 miles west of this site (Scott, 1987, p. 9). Ach and others (1988) reported that that no other geochemical anomalies and no visibly altered rocks were observed in the area of high Ba values in the East Fork High Rock Canyon WSA, making a hydrothermal origin for the Ba anomaly unlikely, and that the anomaly may reflect high levels of Ba in the andesite to dacite flows.

Area B

Area B is 26 miles southeast of Vya and 32 miles north of Gerlach. The area borders the Leadville mining district and the Hog Ranch gold mine on the east. Cottonwood Creek flows through the center of the area. Anomalous As and Sb values were the main indicators of the area. A cluster of anomalous Mo values occurs in the northeast part of the area, north of the Leadville district, and extends northward into area A. Two anomalous Ag values are near the center of the area just west of the Mo cluster. One anomalous Au value is in the northwest edge of the area. In a geochemical study using soil and stream sediments over the Bell Springs deposit, Hog Ranch mine (Bussey and others, 1993), Au, Ag, As, Sb, and Mo in all soil size fractions were found to reveal the nearby underlying ore. Anomalies in the eastern part of area B and along Cottonwood Creek may have resulted from surface drainage from the Hog Ranch mine area and are related to deposits of that mine. Anomalies in samples from eastward-draining streams on the west side of area B, however, may indicate additional deposits. Gold mineralization at the Hog Ranch mine is closely associated with large-scale peralkaline silicic volcanism and with a probable major ring-fracture system (Harvey and others, 1986). Area B is within the area of the ring-fracture system.

Area C

Area C is south of Hog Ranch Mountain and the Leadville mining district. The area is anomalous in a number of elements including Ag, Au, Ba, Bi, Cd, Cu, Mo, Pb, Sb, U, and Zn. The anomaly is in a valley down drainage from the Leadville mine, and may be due to surface drainage from the Leadville deposit, reflecting mineralized rock in the Leadville district, or the downstream sediments may contain stream or wind transported material from mining and milling operations at the mine. The anomaly could also reflect mineralized rock in area C.

Area D

Area D is in the southern end of the Calico Hills, about 16 miles north of Gerlach, and just north of the Trego mining district. Elements with anomalous concentrations are Ag, As, Au, Ba, Cd, Cu, Mo, Sb, and U. This is essentially the same area referred to as "Southern Calico Mountains" in the report on minerals in the Emigrant Trail Study Area by Miller (1993), and was included in that report as an area of development interest. Miller's 1993 report stated that many mining claims had been staked in the area, that numerous claims were still current, and that several drilling programs had been completed. The area is within the Calico Mountains BLM WSA.

Area E

Area E is in the southern end of the Black Rock Range, south of the Black Rock mining district. For convenience the encircled area was extended southward into the Black Rock Desert to include a sample with anomalous values that is probably unrelated to those in the north end of the area. The south sample appears to have been collected from Quinn River sediments and the source of the element enrichment is from some undeterminable location to the northeast. Anomalous concentrations of As, Au, Ba, and Sb, in the north part of the area are probably related to minealized rock in the Double Hot Springs area described by Miller (1993).

Area F

Area F is at Gerlach, at the southern end of the Granite Range. Elements with anomalous concentrations include Ag, As, Cu, Li, Mo, Pb, Sb, U, and Zn. The sample sites are in the area of hot springs of the Gerlach thermal area, and the samples probably contain hot spring deposits. Unconsolidated deposits and granodiorite in the area are hydrothermally altered (Garside and Schilling, 1979).

Area G

Area G is in the area of Mt. Limbo in the southern Selenite Range. The northern end of the area is between the Hooker and San Emidio mining districts. Anomalous As, Mo, U and Zn values occur in the area, with the Mo and Zn being mostly in the northern end. A cluster of prospects and occurences for the commodities, Au, Ag, and U are located in the east-central part of this area, south of Mt Limbo (Tingley, 1989), and part of this anomaly appears to be related to this cluster. The USBM sampled in the area of the prospects as part of the mineral resources study of the Mt Limbo WSA and reported (Rumsey, 1986) that quartz veins and veinlets at prospects are small and have low mineral values, but noted that the deposits have many characteristics considered by Silberman and Berger (1985) typical of hot-springs type, large-tonnage, low-grade gold deposits.

Area H

Area H is a single-sample anomaly, located in the northern end of the Sahwave Mountains. Elements with anomalous values are: Ag, As, Au, Li, Mo, Pb, Sb, U, Zn. The sample site appears to be at a spring, Juniper spring, and, as such, the anomalous values may be from spring precipitates, possibly reflecting subsurface mineralized rock.

Area I

Three separate areas identified by the letter "I", located in the area of the Truckee Range in the southern end of the WSRAA, are noted only for anomalous Au values.

Area J

Area J is a large area in the Black Rock Desert, west of the Jackson Mountains and east of the Black Rock Range. The area contains several geochemical anomalies including the Pinto Mountain and Leonard Creek Slough anomalies identified by Barringer Resources (1982), during the Barringer study of WSAs in the Winnemucca District. The BLM subdivided these two areas and added other zones (U.S. Bureau of Land Management, 1983). Anomalous values of Au, Ag, Sb, and Li were found in samples from at, and near, Pinto Hot Springs. Anomalous values for sinter samples and resource potential for the Pinto Hot Springs area are described in Calzia and others (1987) and in Olson (1985). Anomalous values along the north, east, and west boundaries of Area J probably relate to adjacent mining districts, including the Varyville, Leonard Creek, Jackson Mountains, and Black Rock districts. Many of the samples collected in Area J, particularly those along the Quinn River, are lacustrine sediments derived from unknown localities outside of Area J, and anomalous values found in those samples are therefore not relevant to this area, with the possible exception of Li values. Anomalous values of As, Ag, Au, Cu, Mo, and Zn were found in samples from the southeast part of this area along the east side of the Black Rock Desert, west of the Red Butte mining district, and area "K". This part of the Black Rock Desert is underlain predominantly by Holocene playa and aeolian sand deposits (Calzia and others, 1987). This anomaly is indicated entirely by NURE samples, and was not evident in results for adjacent Barringer (1982) samples.

Moderately anomalous Li values are widespread in Area J, mostly in areas of playa deposits, with values ranging up to about 90 ppm. As part of the U.S. Bureau of mines study of the mineral resources of the Black Rock Desert WSA, Olson (1985) collected 30 samples in the playa area for Li analysis. Although surface values for Li were considered low, Olson (1985) reported that geologic conditions were favorable for higher concentrations at depth.

Area K

Area K is in the Jackson Mountains between the Jackson Mountains mining district to the north, and the Red Butte district to the south. Elements with anomalous concentrations are Ag, As, Au, Cu, Pb, Sb, and Zn. A large part of this area is in the South Jackson Mountains WSA and was studied in detail as part of the mineral resources investigations of that area (Hamilton, 1978; Sorensen and others, 1978).

Area L

Area L is in the southern end of the Jackson Mountains, south of the Red Butte mining district, west of the Jungo district, and north of the Sulphur district (Crofoot/Lewis gold mine). Anomalous concentrations of Ag, As, Au, Cu, Mo, Pb, Sb, U, and Zn were found in samples from this area.

Area M

Area M is a small area with anomalous concentrations of Ag, As, Au, Cu, Sb, and U. The area is on the north flank of the Antelope Range, just west of the Haystack mining district, and southeast of the Sawtooth district.

Area P

Area P is in Silver State Valley, west of the Santa Rosa Range. The anomaly is based on Ag, Au, Mo, Pb, Sb, and U values in samples from two sites in the area. The site on the east side of this area is downstream from a Au, Ag, W mine (Mary Clough mine; Willden, 1964, plate 23) in the Shon mining district and the anomalous values are probably related to that deposit. The anomalous site on the west side of this area is downstream from a Au deposit (Humboldt; Willden, 1964, plate 27) in the Slumbering Hills, and likely relates to that deposit.

Area Q

Area Q is in the west flank of East Range and extends into Buena Vista Valley. Elements found in anomalous concentrations include Ag, As, Au, Ba, Cu, Li, Mo, Pb, Sb, and Zn. Anomalous Au values are widespread in this area; the highest value (0.034 ppb) was found in a sample from near Kyle Hot Springs, suggesting element enrichment from spring deposits. Several intersecting faults and lineaments have been mapped (Garside and Schilling, 1979; but modified from Goldstein and others, 1976) in the Buena Vista Valley portion of area Q. Garside and Schilling (1979, p. 60) reported that the Kyle springs and spring deposits are clearly associated with the intersecting faults. For the valley part of area Q the anomaly may indicate mineralized rock underlying the alluvium.

Area S

Area S is in the central part of the Tobin Range, includes Mount Tobin, and extends into Buffalo Valley on the east. The area borders the Mount Tobin mining district on the south and the Tobin and Sonoma district to the north. Most of the western part of this area is in the Tobin Range BLM WSA. Elements with anomalous values in area S are Ag, As, Au, Ba, Cu, Sb, and Zn. A north-south line of sample sites on the east side of the mountain range, and east of the Tobin Range WSA, with anomalous values for several of the noted elements including Au, Sb, and Ba extends southward from the Tobin and Sonoma mining district into area S. Ba values are also anomalous in samples from throughout most of the Tobin Range. Ba-Hg-Sb mineralization has been described in the southwest flank of the Tobin Range (Lawrence, 1963, p. 203-204), in the Tobin district, where Hg and Sb are the commodities. Johnson (1977, p. 74) reported that barite veins are common in that part of the range, and probably occur in association with Hg at other places. Barringer (1982) data shows some moderately anomalous Hg values in the westsern part of area S, however a prominent cluster of anomalous Hg values is located just to the south of area S, in the Tobin district. Barringer did not sample in the eastern part of area S and NURE samples were not analyzed for Hg.

Area T

Area T is in the Augusta Mountains and extends westward into Dixie Valley, in the southeast corner of the WSRAA. The area is in the northern part of the Augusta Mountains BLM WSA. Elements found in anomalous concentrations are As, Au, Ba, Cd, Li, Mo, Pb, Sb, U, and Zn. The Au was found in only one sample and is a low value. A small cluster of moderate Au and Sb values are located in the southwest part of the area, in approximately the area of the Cain Mountain Zone (U.S. Bureau of Land Management, 1983).

MULTI-ELEMENT SUITES

Factor analysis of the geochemical data for the reanalyzed NURE and USGS stream-sediment and soil samples was used to define geochemical suites that might indicate areas of mineralized rock. Factor analysis is a mathematical technique that can be used to group elements that behave similarly within a data set into a smaller number of variables (Johnston, 1980, p. 127-128). These factors are derived from the correlation matrix to group elements that show geochemically coherent behavior. The mathematical structure within the data set is defined by the factors and may be interpretable in terms of geochemical processes or suites of lithologically related minerals. For further discussion of factor analysis the reader is referred to Davis (1973, p. 473-536) or Johnston (1980, p 127-182).

The R-mode factor analysis program avaliable from the U.S. Geological Survey's STATPAC library (VanTrump and Miesch, 1977) was used for the analysis of the geochemical data. Prior to factor analysis, data for many of the sample sites located outside of the WSRAA to the south were omitted from the data set. The STATPAC program GRIDXY was used to select the highest analytical values within grid areas of 2.6 km^2 and the new values are estimated for the geochemical variables in the center of the grid cells. A varimax solution was obtained from log-transformed data for 32 elements for which detection ratios were greater than 0.90. Detection ratio is the number of uncensored values divided by the total number of samples analyzed for a given element. Data from both 40-element ICP-AES and 10-element ICP-AES analyses for Cu, Pb, and Zn were included in the factor analysis. Three important elements, Ag, Au, and Sb, in the area of the WSRAA were not included in the factor analysis because of low detection ratios. The R-mode factor analysis program first determines the principal components from the correlation coefficient matrix, after which a selected number of factors are rotated using Kaiser's orthogonal varimax criteria. Factor solutions using 5-10 factors were examined and an 8-factor model was selected as the geologically most meaningful for the reconnaissance geochemical data. These 8 factors all have eigenvalues greater than 0.9 and explain 81 percent of the variance in the stream-sediment and soil data. Table 5 lists the significant factors derived from R-mode factor analysis. These factors reflect the distribution and associations of elements related to both lithology and mineralization. Comparison of elements loading strongly into the various factors allows some discrimination between the effects of lithology and mineralization. A generalized geologic map of the WSRAA (from Doebrich and others, 1994; but geology generalized from Stewart and Carlson, 1978; and Jennings, 1977) showing the approximate locations of geologic and structural features, and the approximate locations of mining districts and anomalous areas is used as a base for plots of factor scores. Plots of sample localities (centers of gridded areas) greater than the 90th percentile of scores determined by R-mode factor analysis for the data set are shown in figures 13 to 20.

Table 5. Varimax rotation factor loadings for stream-sediment and soil data

[Leaders (---) indicate loadings less than 0 40. Analyses by 40-element inductively coupled plasma-atomic emission spectrometry (ICP-AES) except where noted by an asterisk (*), which indicates data determined by 10-element ICP-AES, and where noted by aa, which indicates data determined by atomic absorption; na, not applicable (element not used in factor analysis); DR, detection ratio]

Factor	1	2	3	4	5	6	7	8	DR
Al	---	---	---	---	81	---	---	---	1.000
Ca	---	---	---	.78	---	---	---	---	1.000
Fe	.80	---	---	---	---	---	---	---	1.000
K	---	.50	---	---	---	---	---	---	1.000
Mg	.73	---	---	.46	---	---	---	---	1.000
Na	---	---	---	---	.72	---	---	---	1.000
P	.56	---	---	.48	---	---	---	---	1.000
Ti	.67	---	---	---	.42	---	---	---	1.000
Mn	.52	---	---	---	---	.45	---	---	1.000
Ag	na	na	na	na	na	na	na	na	.004
As	na	na	na	na	na	na	na	na	.453
Au	na	na	na	na	na	na	na	na	.000
Ba	---	---	---	---	---	---	.84	---	1.000
Be	---	.56	---	---	---	---	---	---	.987
Bi	na	na	na	na	na	na	na	na	.001
Cd	na	na	na	na	na	na	na	na	.025
Ce	---	.86	---	---	---	---	---	---	1.000
Co	.89	---	---	---	---	---	---	---	1.000
Cr	.88	---	---	---	---	---	---	---	.999
Cu	.81	---	---	---	---	---	---	---	1.000
Eu	na	na	na	na	na	na	na	na	.010
Ga	---	---	---	---	.72	---	---	---	1.000
Ho	na	na	na	na	na	na	na	na	.000
La	---	.91	---	---	---	---	---	---	1.000
Li	---	---	---	---	---	---	---	.70	1.000
Mo	na	na	na	na	na	na	na	na	.036
Nb	---	.69	---	---	---	---	---	---	.997
Nd	---	.91	---	---	---	---	---	---	.999
Ni	.87	---	---	---	---	---	---	---	.997
Pb	---	---	.52	---	---	---	---	---	.985
Sc	.88	---	---	---	---	---	---	---	999
Sn	na	na	na	na	na	na	na	na	.006
Sr	---	---	---	.76	---	---	---	---	1.000
Ta	na	na	na	na	na	na	na	na	.000
Th	---	79	---	---	---	---	---	---	948
U	na	na	na	na	na	na	na	na	000
V	83	---	---	---	---	---	---	---	1 000
Y	---	49	---	---	---	79	---	---	1 000
Yb	---	---	---	---	---	83	---	---	961
Zn	---	---	76	---	---	---	---	---	1.000
Ag*	na	na	na	na	na	na	na	na	.178
As*	---	---	.53	---	---	---	---	---	.901
Au*	na	na	na	na	na	na	na	na	.002
Bi*	na	na	na	na	na	na	na	na	.013
Cd*	---	---	.71	---	---	---	---	---	.914
Cu*	.79	---	---	---	---	---	---	---	1.000
Mo*	---	---	.73	---	---	---	---	---	995
Pb*	---	---	73	---	---	---	---	---	.999
Sb*	na	na	na	na	na	na	na	na	368
Zn*	.46	---	.77	---	---	---	---	---	1.000
Au-aa	na	na	na	na	na	na	na	na	.132
Percent of total variance explained by factor	29	19	15	5	4	3	3	3	

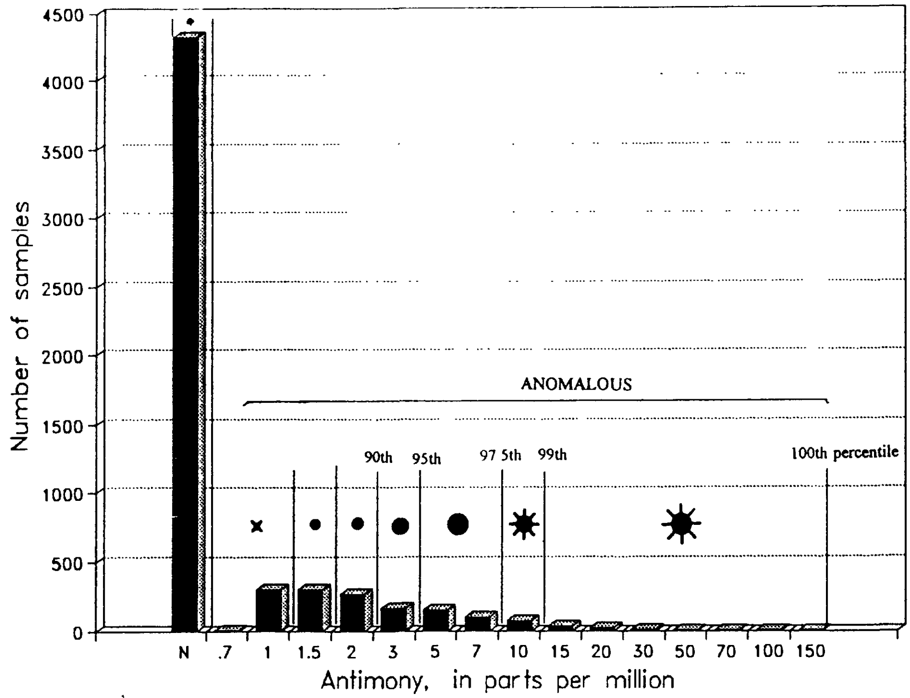


Figure 3. Histogram showing concentration of antimony in 5,776 stream-sediment and soil samples, Winnemucca-Surprise Resource Assessment Area. Symbols correspond to symbols used in plate 1.

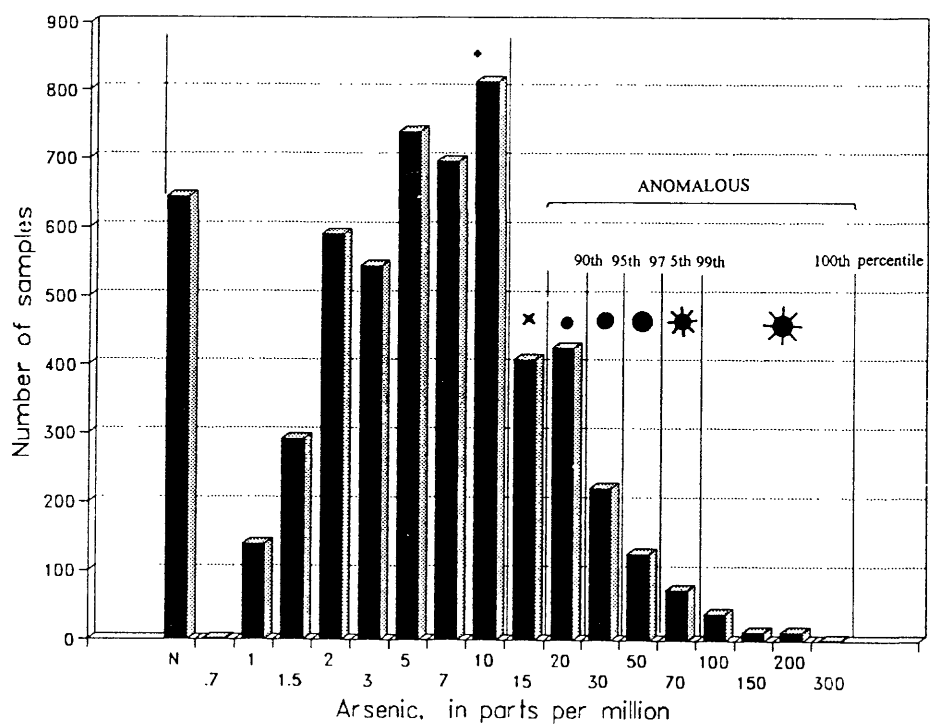


Figure 4 Histogram showing concentration of arsenic in 5,776 stream-sediment and soil samples, Winnemucca-Surprise Resource Assessment Area Symbols correspond to symbols used in plate 2

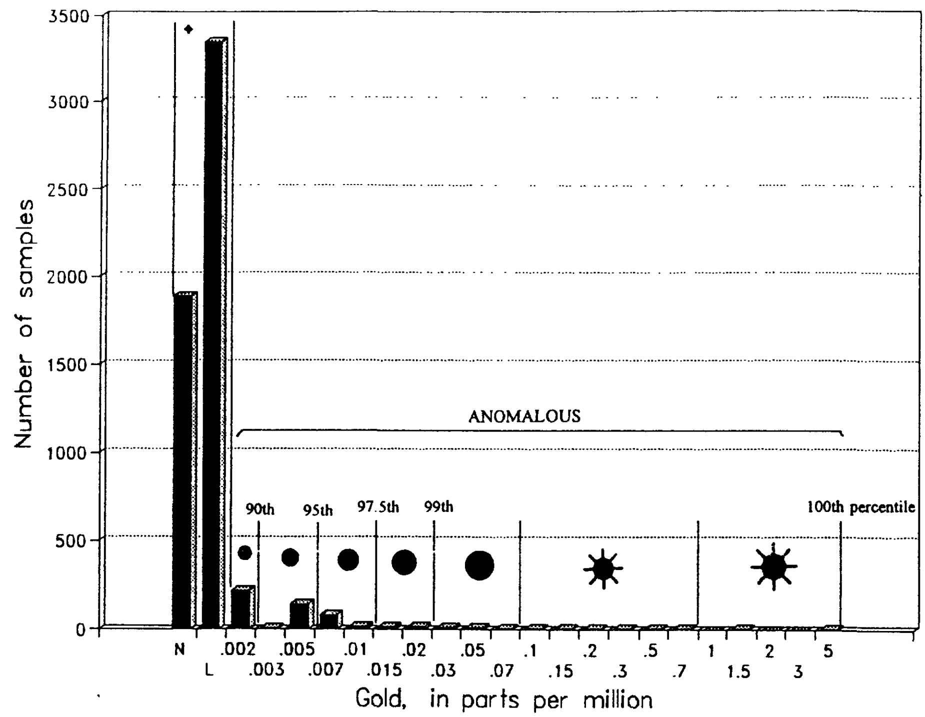


Figure 5. Histogram showing concentration of gold in 5,776 stream-sediment and soil samples, Winnemucca-Surprise Resource Assessment Area. Symbols correspond to symbols used in plate 3.

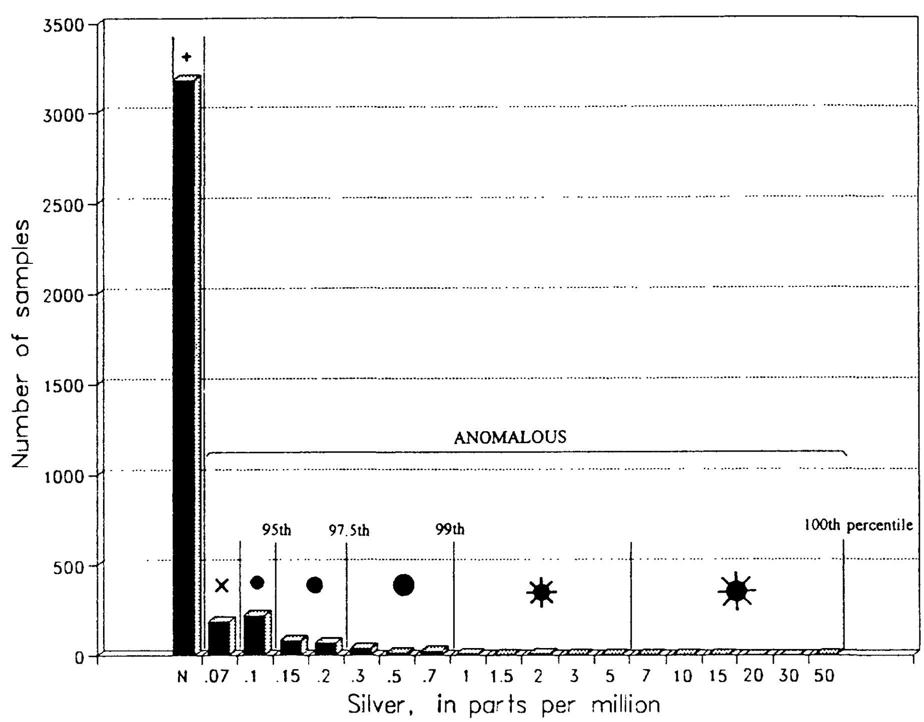


Figure 6 Histogram showing concentration of silver in 3,872 stream-sediment and soil samples, Winnemucca-Surprise Resource Assessment Area Symbols correspond to symbols used in plate 4

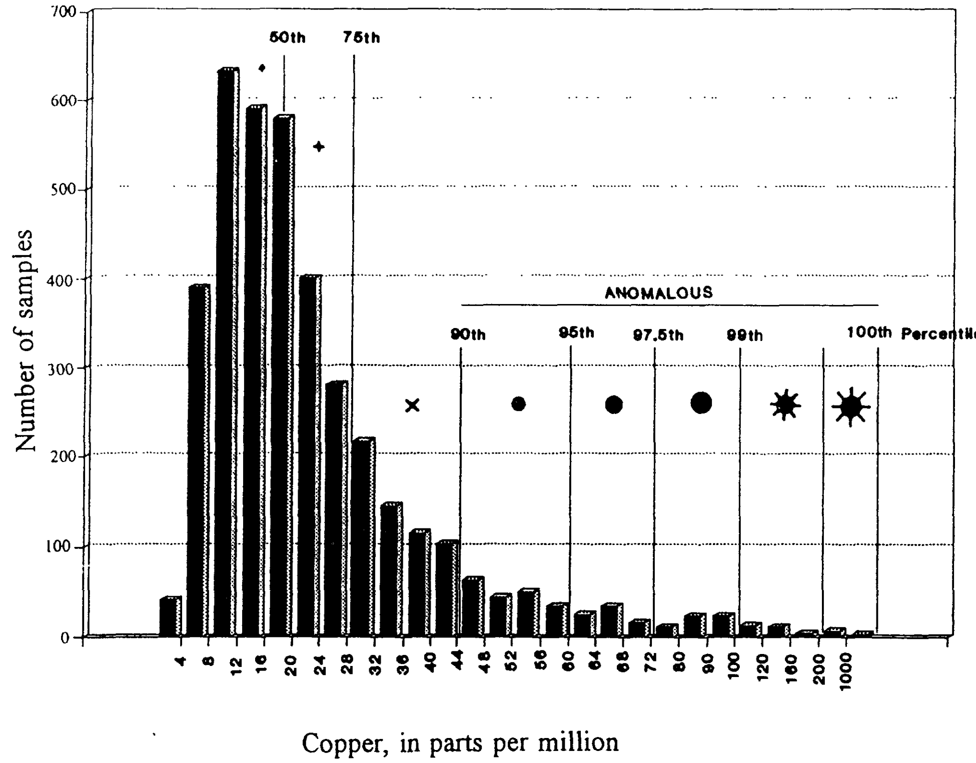


Figure 7. Histogram showing concentration of copper in 3,872 stream-sediment and soil samples, Winnemucca-Surprise Resource Assessment Area. Symbols correspond to symbols used in plate 5.

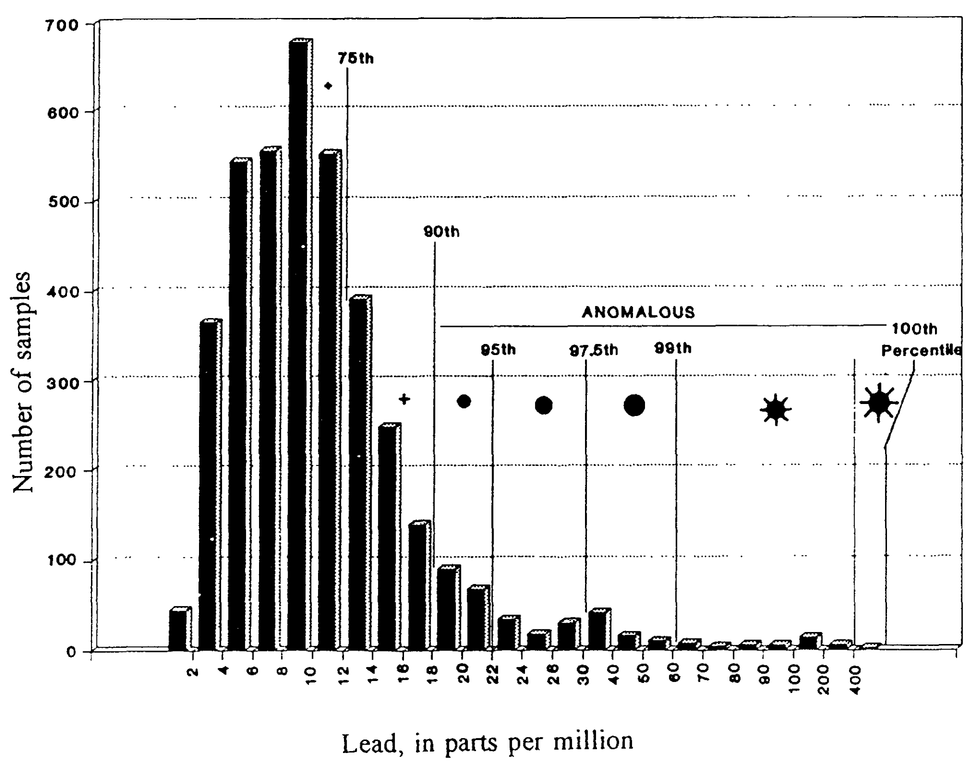


Figure 8 Histogram showing concentration of lead in 3,872 stream-sediment and soil samples, Winnemucca-Surprise Resource Assessment Area. Symbols correspond to symbols used in plate 6

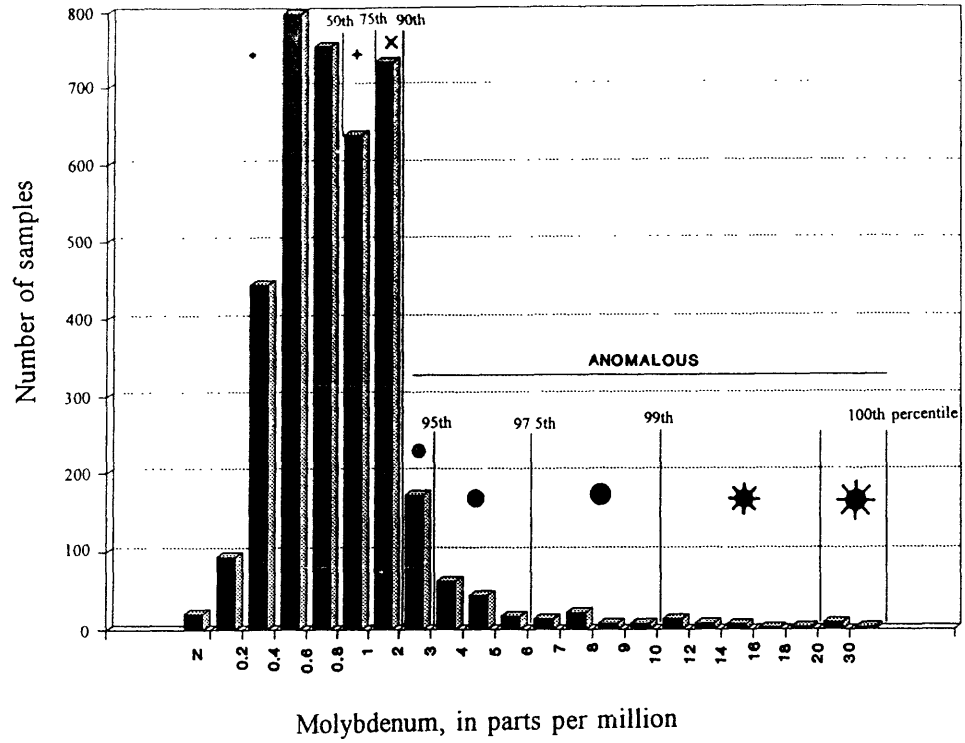


Figure 9 Histogram showing concentration of molybdenum in 3,872 stream-sediment and soil samples, Winnemucca-Surprise Resource Assessment Area. Symbols correspond to symbols used in plate 7

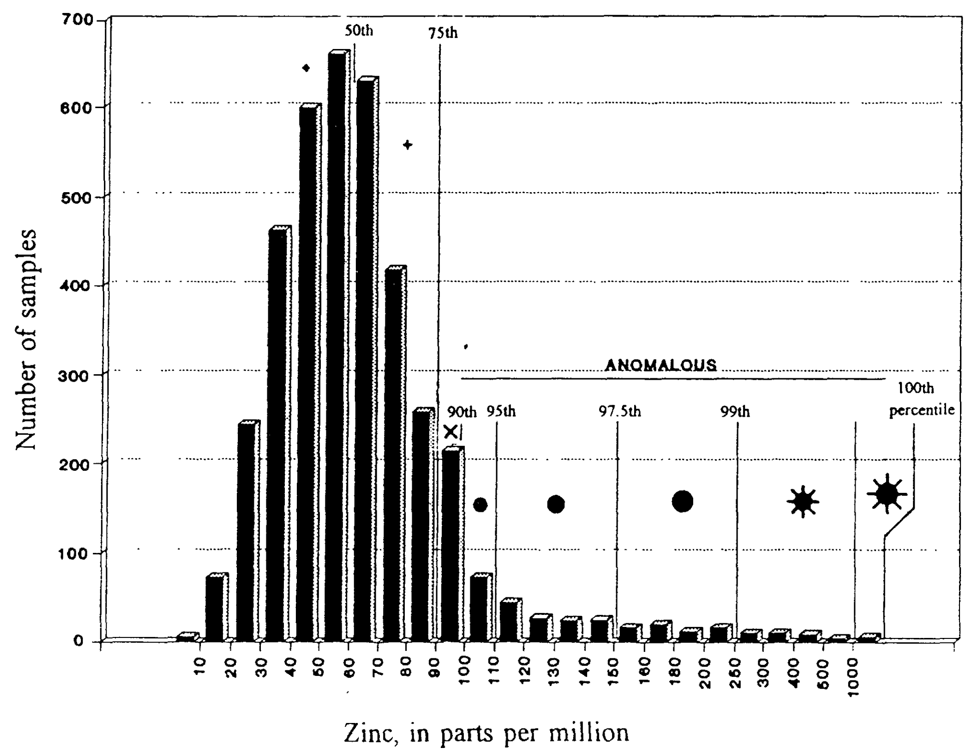


Figure 10 Histogram showing concentration of zinc in 3,872 stream-sediment and soil samples, Winnemucca-Surprise Resource Assessment Area Symbols correspond to symbols used in plate 8.

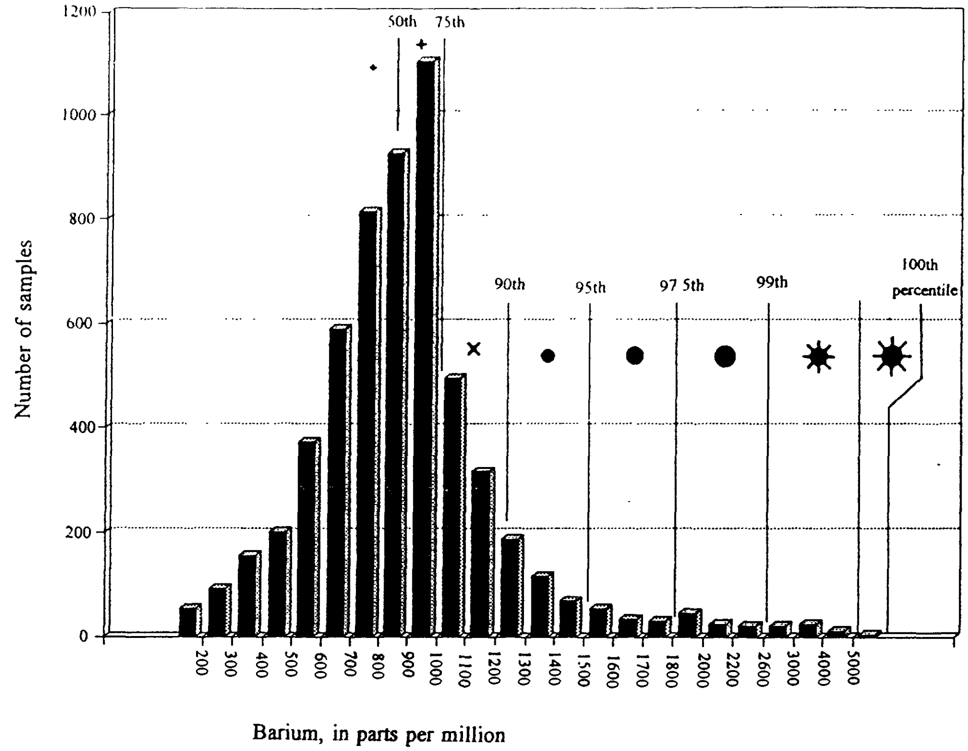


Figure 11. Histogram showing concentration of barium in 5,776 stream-sediment and soil samples, Winnemucca-Surprise Resource Assessment Area. Symbols correspond to symbols used in plate 9.

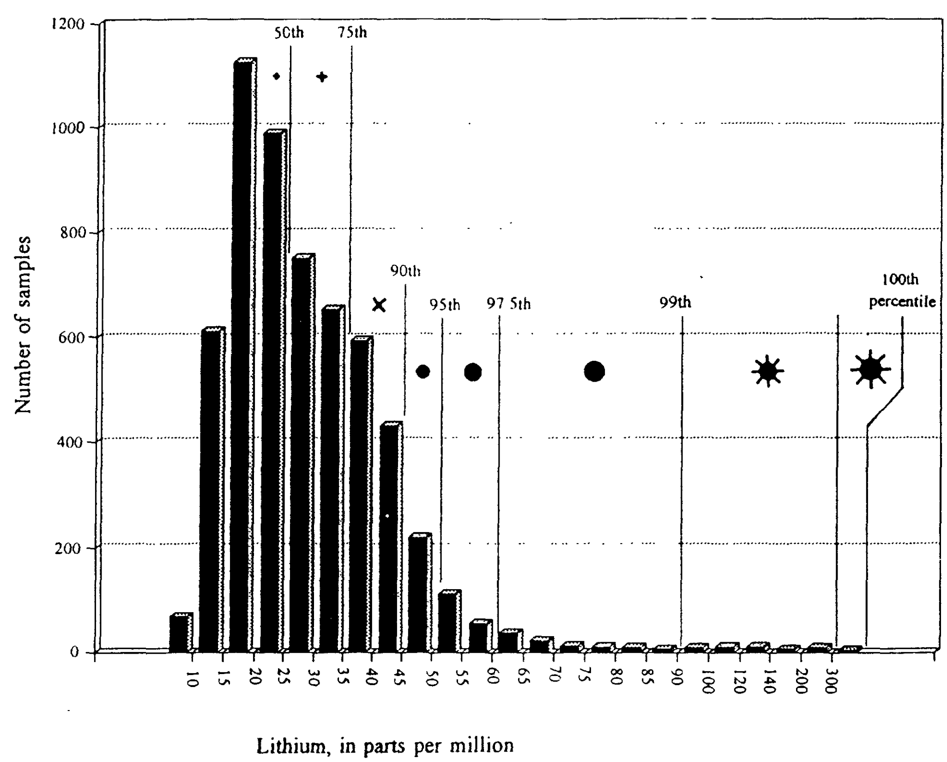
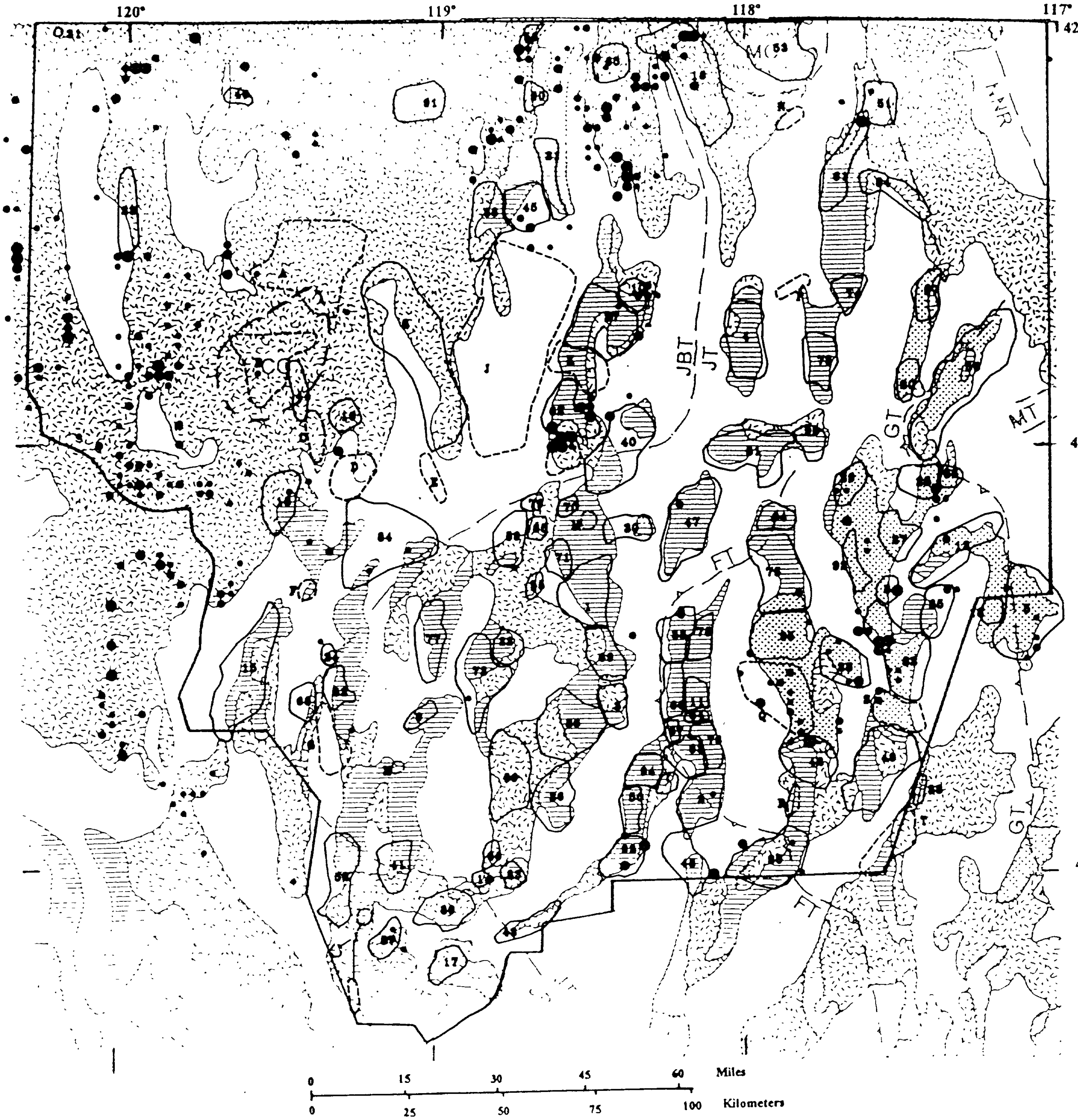


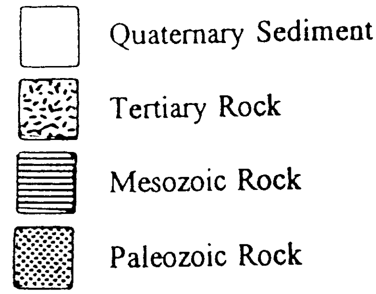
Figure 12 Histogram showing concentration of lithium in 5,776 stream-sediment and soil samples, Winnemucca-Surprise Resource Assessment Area Symbols correspond to symbols used in plate 10



PERCENTILE

• 90-95 • 95-97 5 ● 97 5-99 ● 99-100

Figure 13 Distribution map for upper 10 percentile of varimax factor 1 scores (Fe, Mg, P, Ti, Mn, Co, Cr, Cu, Ni, Sc, V, and Zn)



Base is a generalized geologic map of the WSRAA project area and vicinity from Doebrich and others (1994) with geology generalized from Stewart and Carlson (1978) and Jennings (1977). Solid thick line is approximate boundary of WSRAA project area. Dashed thick lines are the approximate locations of geologic and structural features: MC, McDermitt caldera; CC, Cottonwood Creek caldera complex; GT, Golconda thrust; FT, Fencemaker thrust; JT, Jungo terrane; JBT, Jackson/Black Rock terrane; NNR, Northern Nevada rift; MT, Midas trough. The approximate locations of mining districts (numbered areas), and the locations of areas of geochemical anomalies which are not definitely related to mining districts (areas identified by letters) are also shown.

Factor 1 (fig. 13) contains high varimax loadings for Fe, Mg, P, Ti, Mn, Co, Cr, Cu, Ni, Sc, V, and Zn, that reflect basic rocks, chiefly in the north-central and western parts of the WSRAA. In the southeastern part of the WSRAA factor 1 reflects areas underlain by the Pennsylvanian and Permian Pumpernickel Formation, which contains mafic volcanic rocks (Johnson, 1977, p.7). An area where factor 1 are high is in the area of a massive sulfide deposit in the northern part of the Tobin and Sonoma Range mining district, and west of China Mountain. High factor scores for factor 1 also occur in the southern part of the Jackson Mountains in the area of the Red Butte mining district. These occurrence are in an area that has been prospected for iron, and massive sulfide deposits (Hamilton, 1987; Sorensen, and others, 1987).

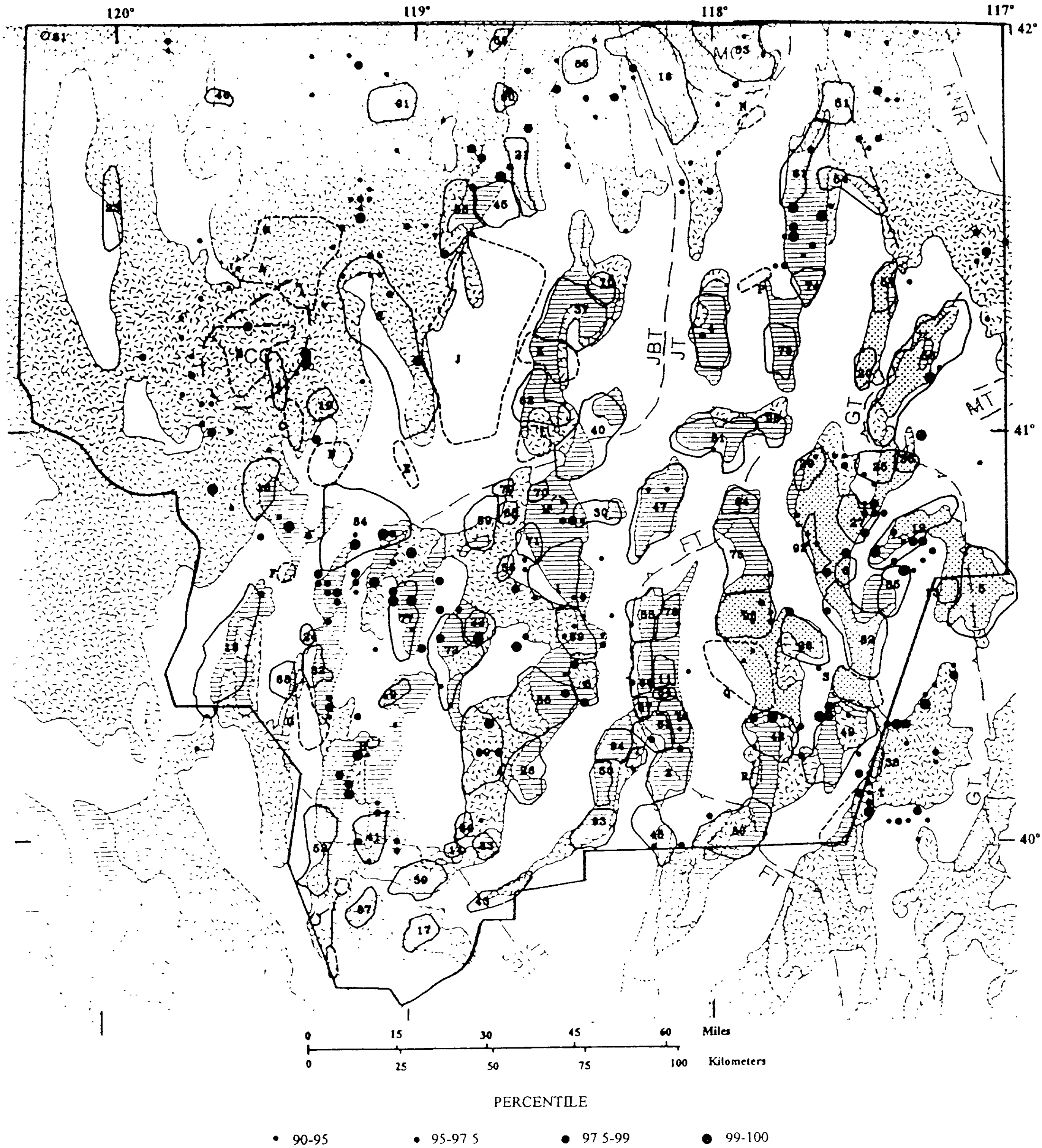
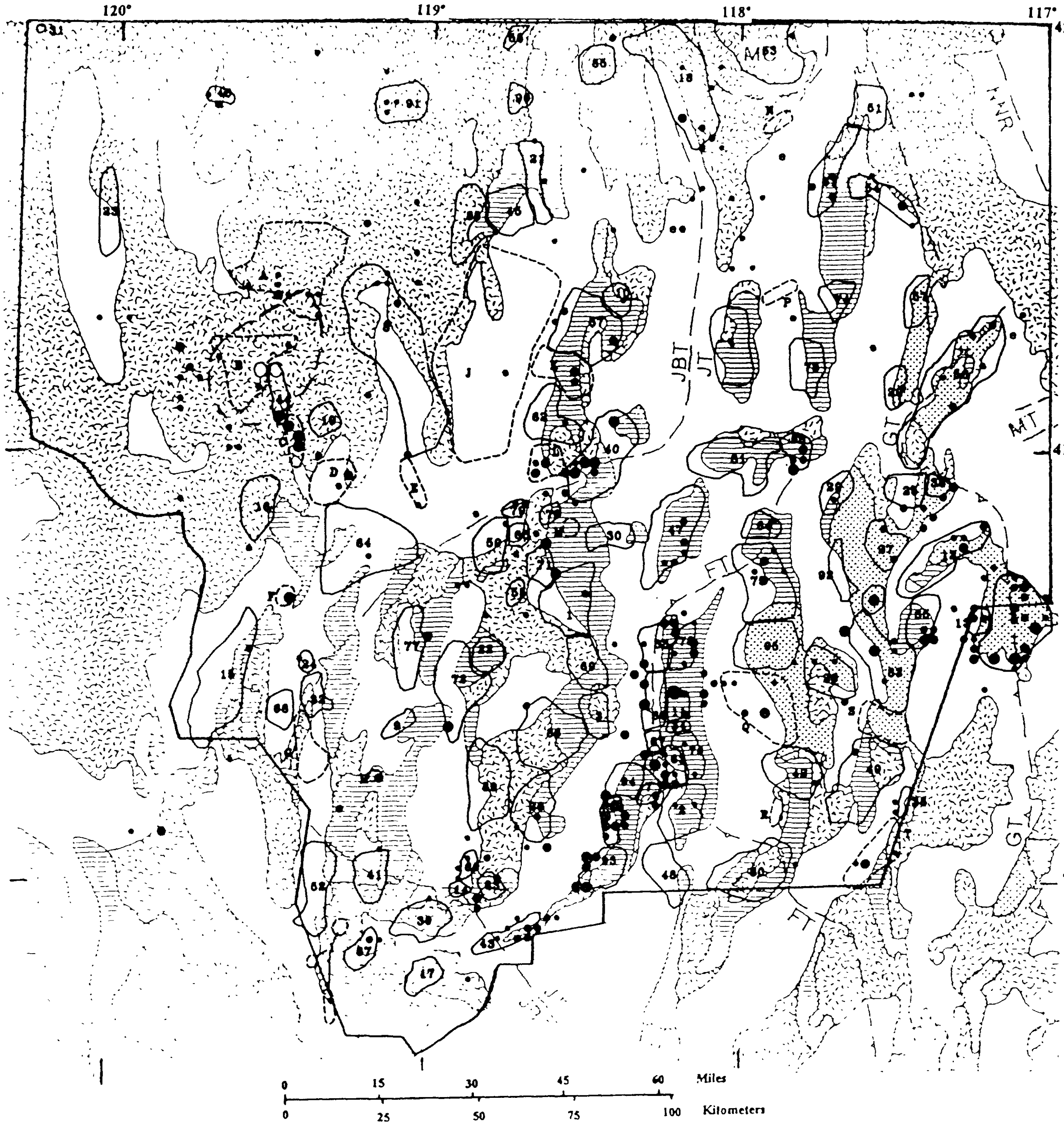


Figure 14 Distribution map for upper 10 percentile of varimax factor 2 (La, Nd, Ce, Th, Nb, Be, K, and Y) For explanation of geologic base see figure 11

Factor 2 (fig 14), with high loadings for La, Nd, Ce, Th, Nb, Be, K, and Y, is dominantly a rare-earth lithophile enrichment associated with silicic volcanic and granitic rocks



PERCENTILE

• 90-95 • 95-97.5 ● 97 5-99 ● 99-100

Figure 15 Distribution map for upper 10 percentile of varimax factor 3 (As, Cd, Mo, Pb, and Zn) For explanation of geologic base see figure 11.

Factor 3 (fig 15) is a mineralization factor with high loadings in As, Cd, Mo, Pb, and Zn High factor 3 scores are in the areas of many of the mining districts in the WSRAA, and also in some of the areas of geochemical anomalies not definitely related to the mining districts The distribution of sites with high loadings in Area A, and west and south of Area B suggest a relationship to the fractured rim area of the Cottonwood Creek volcanic center

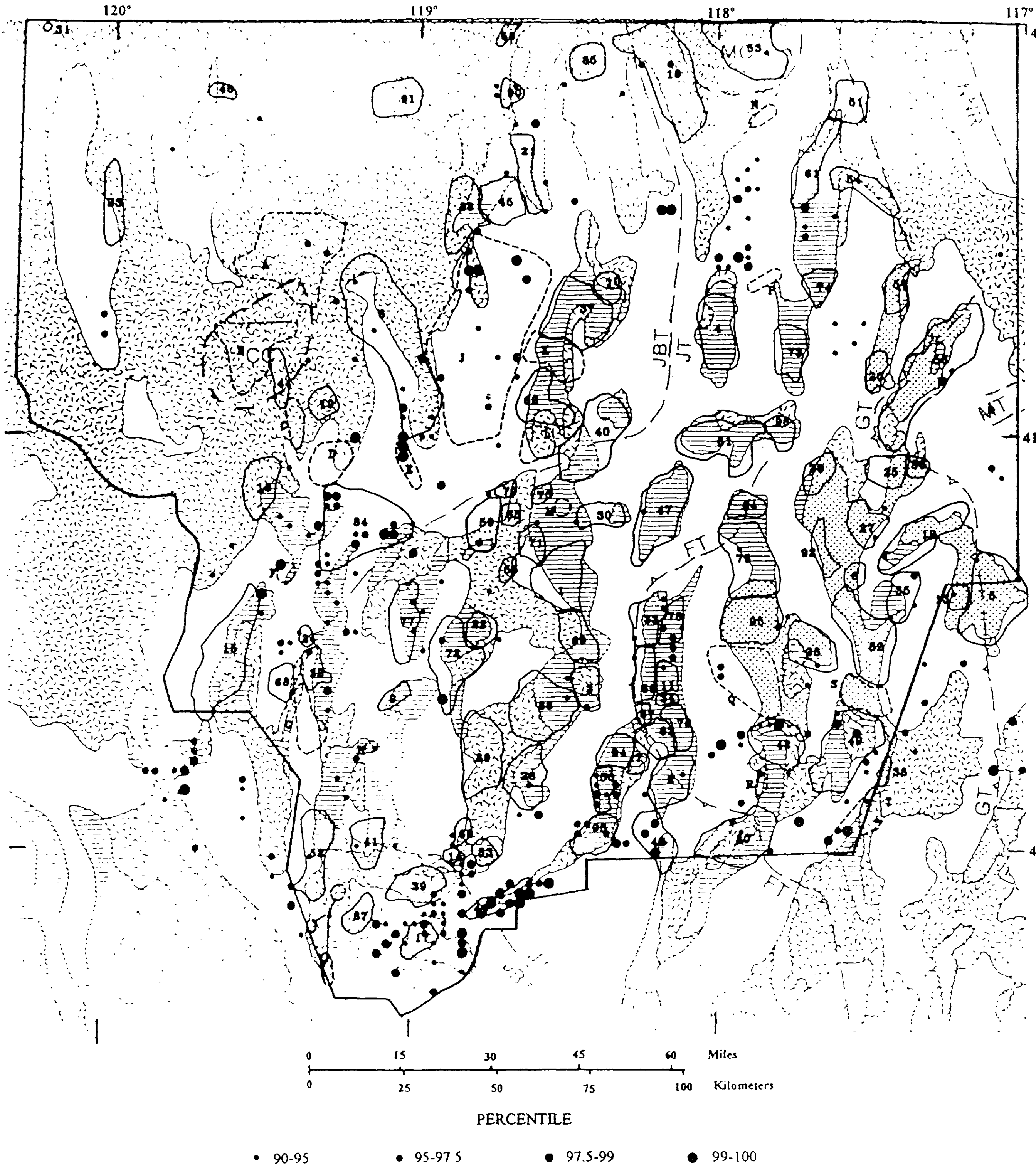


Figure 16 Distribution map for upper 10 percentile of varimax factor 4 (Ca, Sr, P, and Mg) For explanation of geologic base see figure 11

Factor 4 (fig 16) has high loadings for Ca, Sr, P, and Mg. Samples with high factor 4 scores plot mostly in areas underlain by limestone or other calcareous rocks Travertine deposits at Pinto hot springs (Hose and Taylor, 1974, p 14) in the Black Rock Desert probably account for high factor 4 loadings in that area, and elsewhere at hot spring locations A notable area with high factor 4 scores is in the area of the Lake mining district, at the southern end of the WSRAA The high factor 4 scores in this area probably mostly relate to Lake Lahonton tufa deposits and a shell limestone deposit of lacustrine origin described in this area (Lawrence, 1963, p 32-35), and also to limestone bedrock

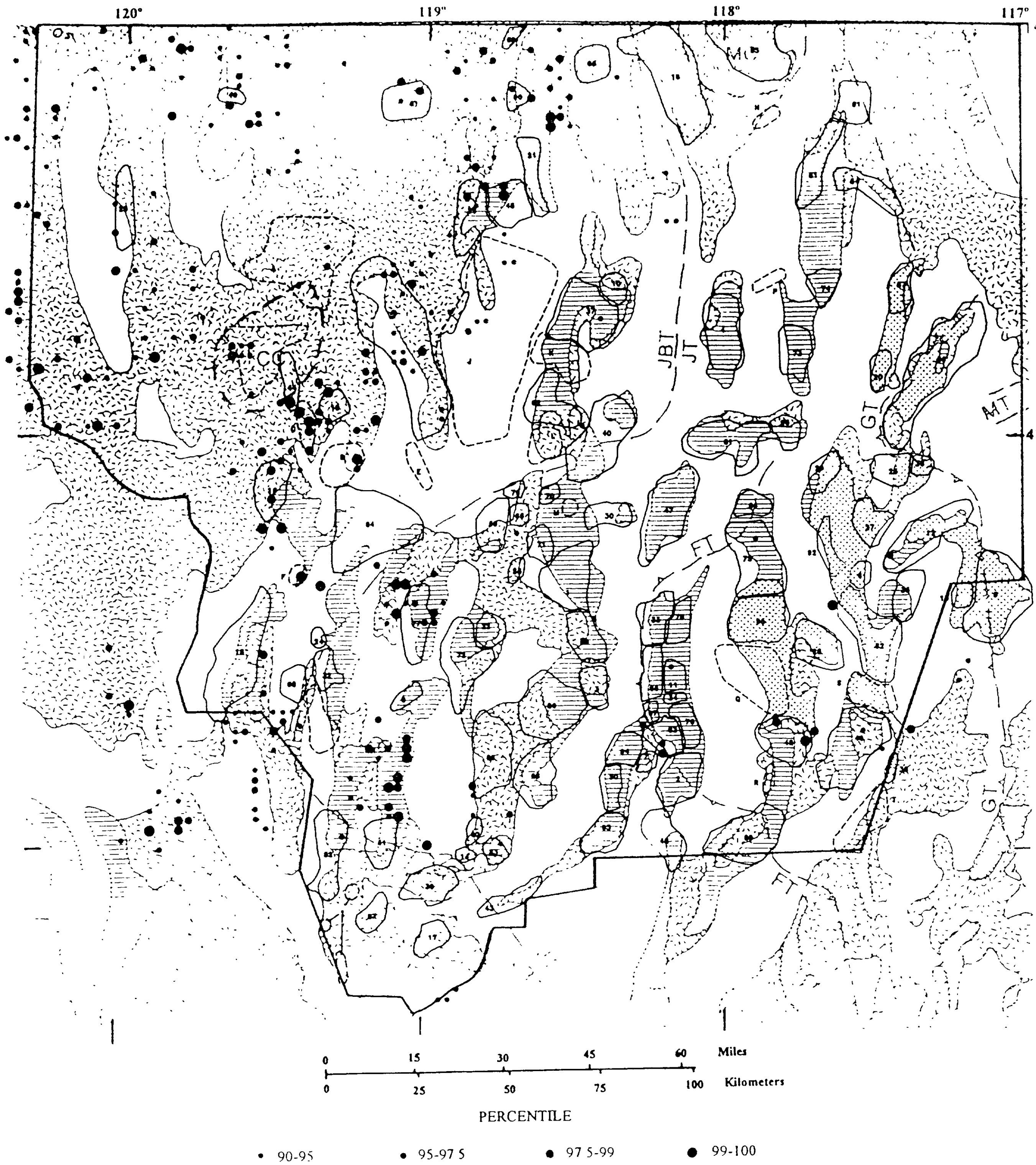


Figure 17 Distribution map for upper 10 percentile of varimax factor 5 (Al, Na, Ga, and Ti) For explanation of geologic base see figure 11

Factor 5 (fig 17) is a lithologic factor with high loadings for Al, Na, Ga, and Ti Samples with high factor 5 loadings plot chiefly in areas underlain by Mesozoic granitic rocks

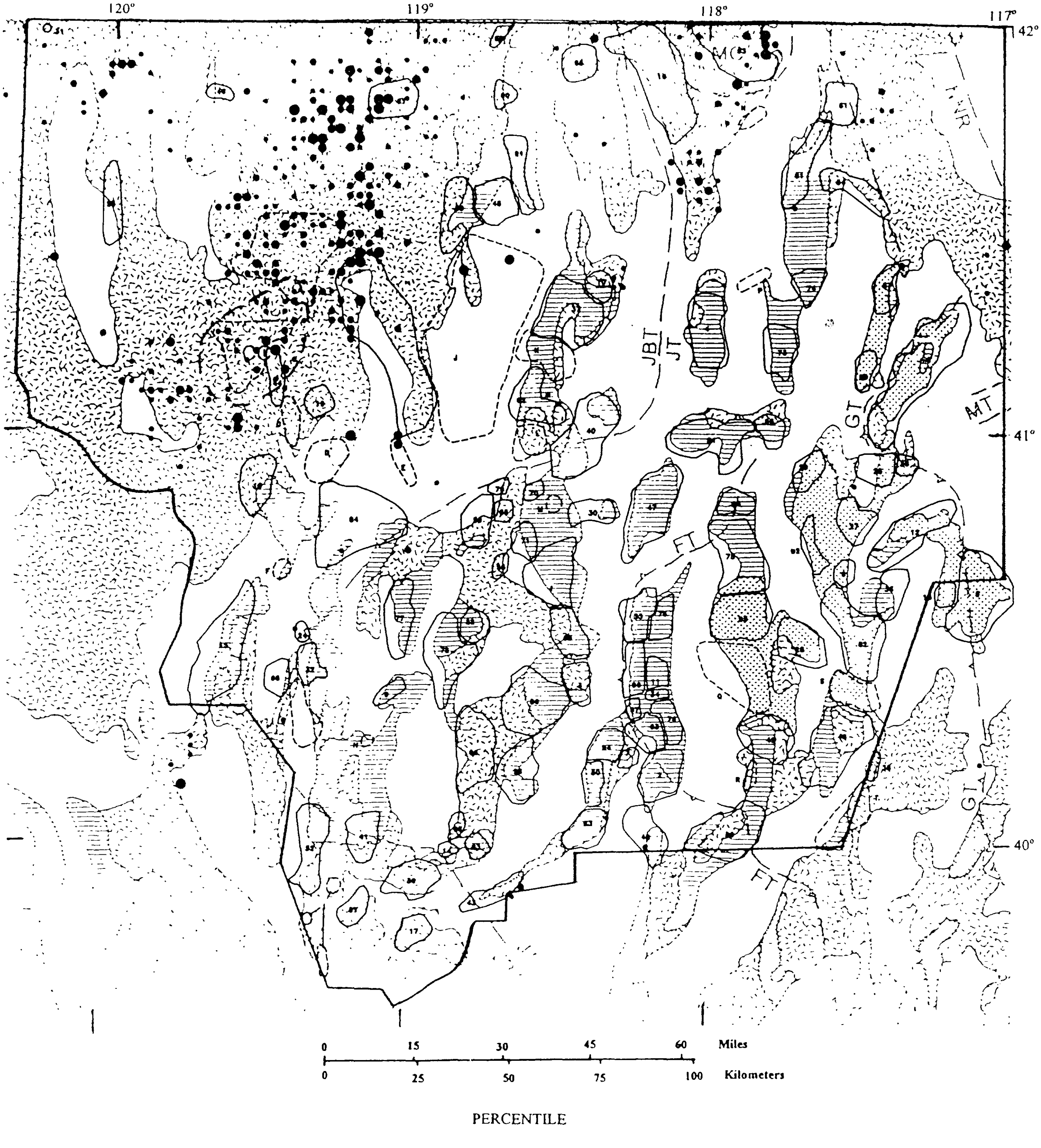


Figure 18. Distribution map for upper 10 percentile of varimax factor 6 (Yb, Y, and Mn) For explanation of geologic base see figure 11

Factor 6 (fig 18), with high loadings in Yb, Y, and Mn, is dominantly a heavy rare-earth lithophile enrichment associated with Tertiary volcanic rock Samples with the highest varimax scores for this factor plot mostly in the northwest part of the WSRAA

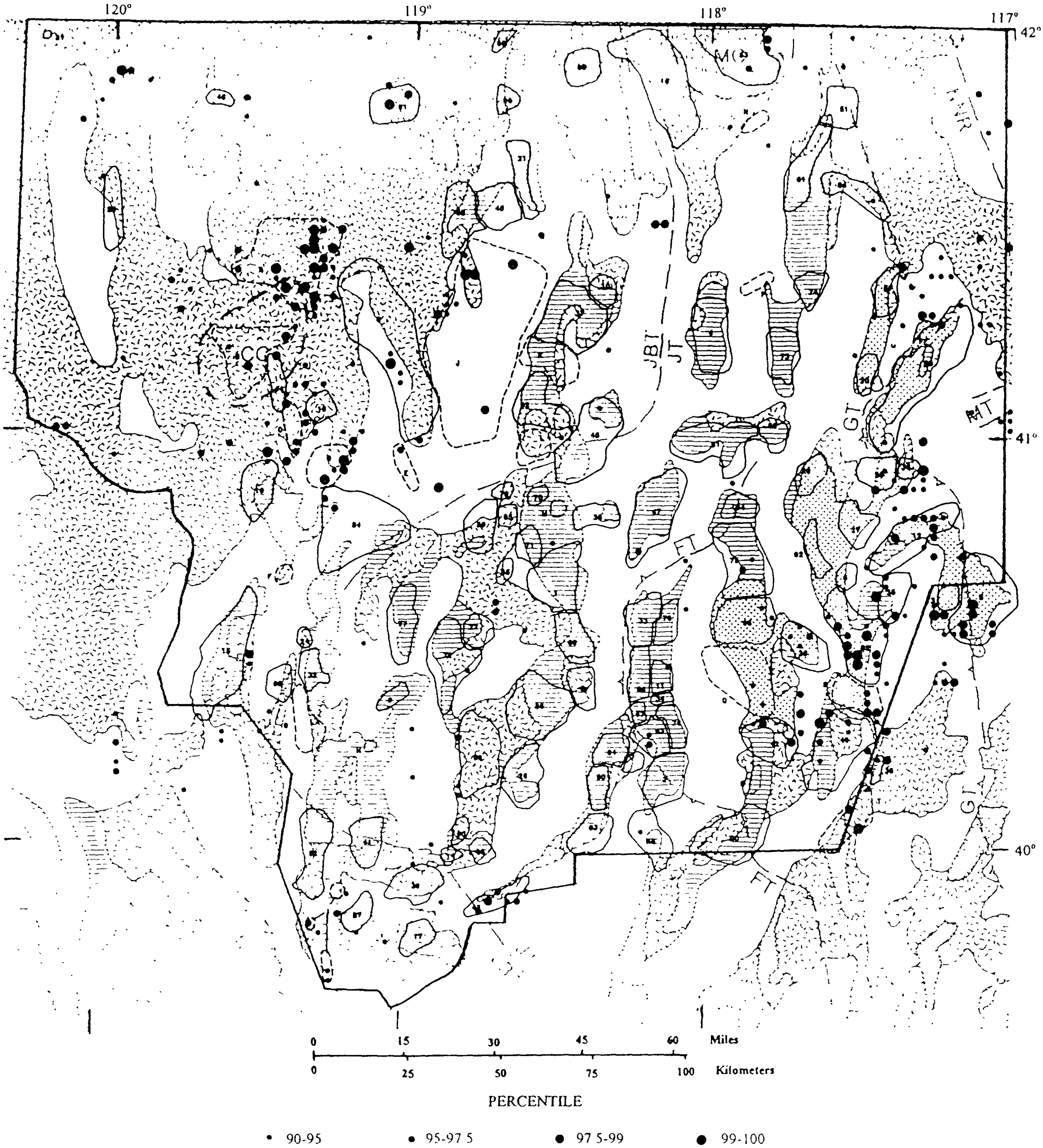


Figure 19 Distribution map for upper 10 percentile of varimax factor 7 (Ba)
For explanation of geologic base see figure 11

Factor 7 (fig 19) is dominated by Ba In the southeast part of the WSRAA samples with high factor 7 scores plot in several mining districts and is likely a mineralization factor In the northwest part of the WSRAA high factor 7 loadings are located in the area of the East Fork High Rock Canyon WSA A Ba anomaly (plate 9) in this area was considered to be due to high levels of Ba in andesite to dacite flows rather than to a hydrothermal origin (Ach, and others, 1988, p 8)

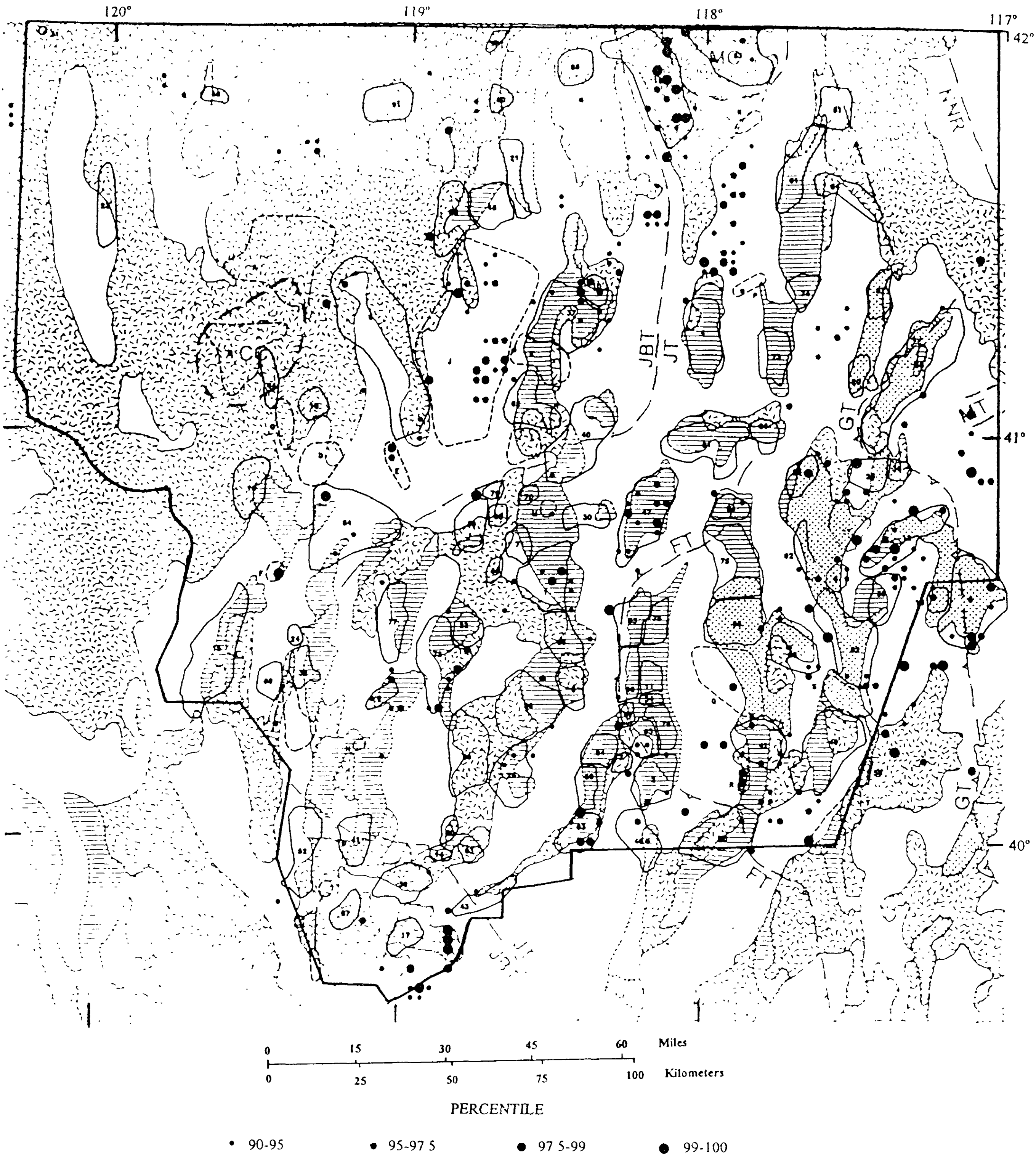


Figure 20 Distribution map for upper 10 percentile of varimax factor 8 (Li)
For explanation of geologic base see figure 11

Factor 8 (fig 20) is dominated by Li The most notable grouping of samples with high factor 8 scores is in the area of lithium deposits of the McDermitt caldera complex (Rytuba and Glansman, 1979), in an area underlain by Tertiary tuffaceous sediments and rhyolite ash-flow tuff (McKee, 1976) Clusters occur southward from the area of the McDermitt caldera complex in alluvial deposits of the Quinn River Valley and the Kings River Valley and probably represent sediments eroded from the caldera complex Notable clusters occur in playa and alluvial deposits elsewhere in valley areas including the Black Rock Desert Some of the isolated individual samples with high factor 8 scores occur at hot springs, such as Pinto and Gerlach hot springs In many areas high factor 8 loadings probably reflect higher, but normal, contents of Li in the bedrock from which the stream sediments were derived

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