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ANALYTICAL RESULTS FOR SOIL SAMPLES COLLECTED IN THE NORTHERN SAN LUIS VALLEY, COLORADO

By

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ABSTRACT

During 1992 and 1993 a total of 395 soil samples were collected in the northern part of the San Luis Valley, Colorado. The study was part of a multimedia geochemical and geophysical survey funded by the U.S. Department of Energy. The purpose of the survey was to seek surface evidence for possible extensions of the Valley View Hot Springs and Mineral Hot Springs Known Geothermal Resource Areas. Sampling and analysis of the soils are described and analytical results are listed in this report.

INTRODUCTION

The San Luis Valley, an east-dipping half graben, is the geomorphic expression of the Rio Grande Rift in southern Colorado. The valley lies between low foothills of the San Juan Volcanic Field to the west and the steeply rising Sangre de Cristo Range to the east. The prominent late-Tertiary age Sangre de Cristo fault is the bounding fault of the Sangre de Cristo Range; the fault runs the length of the west side of the range and cuts across several structural features. The Holocene Villa Grove fault zone trends northwesterly across the northern San Luis Valley from the vicinity of Valley View Hot Springs (Knepper, 1976; Knepper and Marrs, 1971). The western side of the valley is cut by the Kerber, Noland, and Villa Grove faults which extend northwesterly from the vicinity of Mineral Hot Springs (Scott and others, 1978) (fig. 1).

Soil and soil-gas surveys were made in 1992 and 1993 in the northern San Luis Valley, Colorado, as part of a multimedia geochemical study and remote-sensing study to seek surface evidence of any possible extensions of two known geothermal resource areas (KGRAs). The first KGRA, Mineral Hot Springs (spring water temperatures 32-55°C), occurs in valley fill about midway between the San Juan Volcanic Field on the west side of the valley and the Sangre de Cristo Range on the east. The second KGRA, Valley View Hot Springs (spring water temperatures 31-33°C), lies along the prominent Sangre de Cristo fault. Although the temperatures of these geothermal waters are too low to indicate the presence of high-temperature geothermal systems, waters of these temperatures can be used for space heating, agriculture, and industry.

Other data releases in this multimedia study include analyses of rabbitbrush samples (Erdman and VanTrump, 1993), results of a resistivity survey near Mineral Hot Springs (Zohdy and Bisdorf, 1993), and results of a soil-gas survey (Hinkle, 1993).

ACKNOWLEDGEMENTS

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SAMPLE COLLECTION AND ANALYSIS

Samples were collected along roads and trails. Soils were sampled by scraping away debris on the ground surface and collecting the soil at 2 - 10 cm depth. The air-dried samples were sieved to -80 mesh (<180 um), and then pulverized to -100 mesh (<150um).

The prepared soil samples were analyzed by a partial-extraction Induction-Coupled Plasma (ICP) method that isolates and measures the secondary oxide-related metallic-element content of the sample (Motooka, 1990). Metal content related to the silicate lattice of common rock-forming minerals is not measured by the partial-extraction technique. Lower limits of determination for elements analyzed by the technique are shown in table 1a; neither Au nor Bi was detected in any of the samples at the lower limit of determination shown. The soil samples were also analyzed for mercury content (lower limit of determination = 0.02 ppm) (O'Leary, 1990) and for hydrogen-ion content (pH) (Jackson, 1958). One sinter sample each from the Valley View and Mineral Hot Springs was analyzed by a 40-element ICP procedure (Briggs, 1990); lower limits for the elements analyzed are shown in table 1b.

DESCRIPTION OF THE DATA TABLES

Data from the analyses were entered into an IBM-compatible personal computer and stored on disks, using the .WQ1 QuattroPro program (Borland International, Inc.). The data were converted into the U.S. Geological Survey STATPAC format for statistical analyses (Grundy and Miesch, 1987), and into the U.S. Geological Survey GSMAP format for plotting (Selner and Taylor, 1992). Table 2a shows the maximum, minimum, mean, and standard deviations for the combined 1992 and 1993 data sets, and table 2b shows the correlation coefficients for these data; only unqualified data are included in tables 2a and 2b. Samples with missing or incompete data are not included. Table 3 lists the results of the 395 soil-gas analyses; samples numbered one through 120 were collected in 1992 and samples 121 through 397 were collected in 1993. The letter "B" indicates no analysis for a particular variable, generally because of insufficient sample. Table 4 lists the results of ICP analysis of the two sinter samples.

The data in tables 2 - 4 are found in QUATTRO.PRO (.WQ1 filename extension) format on the floppy disk in the pocket of this report. Table 3 data in .stp (STATPAC) format are also included on the disk. The .stp format may be converted into other formats by use of the STP2DAT conversion program included on the disk.

Plots of the analytical results for the soil samples are shown in figures 2-11. The plots show the location of samples whose concentrations are in the less than 50th percentile (+), 50th-90th percentiles ( ) , and greater than 90th percentile ( ).

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Monthly List Note for OF 94-297.

Requirements: IBM or compatible PC using MS DOS, with a 5 1/4 inch, 360K drive.

Table 1a. ICP-AES Detection Limits for 10 Elements: Partial-Extraction Method.

Element	Lower Limit of Determination
Ag	ppm 0.045
As	ppm 0.600
Au	ppm 0.100
Bi	ppm 0.670
Cd	ppm 0.050
Cu	ppm 0.050
Mo	ppm 0.090
Pb	ppm 0.600
Sb	ppm 0.670
Zn	ppm 0.050

Table 1b. ICP-AES Detection Limits for 40 Elements

Element	Lower Limit of Determination
Al	% .005
Ca	% .005
Fe	% .005
K	% .05
Mg	% .005
Na	% .005
P	% .005
Ti	% .005
Ag	ppm 2
As	ppm 10
Au	ppm 8
Ba	ppm 1
Be	ppm 1
Bi	ppm 10
Cd	ppm 2
Ce	ppm 4
Co	ppm 1
Cr	ppm 1
Cu	ppm 1
Eu	ppm 2
Ga	ppm 4
Ho	ppm 4
La	ppm 2
Li	ppm 2
Mn	ppm 4
Mo	ppm 2
Nb	ppm 4
Nd	ppm 4
Ni	ppm 2
Pb	ppm 4
Sn	ppm 5
Sc	ppm 2
Sr	ppm 2
Ta	ppm 40
Th	ppm 4
U	ppm 100
V	ppm 2
Y	ppm 2
Yb	ppm 1
Zn	ppm 2

Table 2a. Basic statistics for unqualified soil data.

Element	Number Unqualified Values *	Minimum	Maximum	Mean *	Standard Deviation *
Ag (ppm)	66	L	3.90	0.23	0.49
As (ppm)	392	L	27.0	2.7	1.8
Cd (ppm)	279	L	1.10	0.24	0.15
Cu (ppm)	396	13	77	24	7
Mo (ppm)	396	0.36	5.20	0.92	0.52
Pb (ppm)	396	5.5	130	21	12
Sb (ppm)	30	L	4	1.7	0.89
Zn (ppm)	396	16	290	85	38
Hg (ppb)	396	10	80	20	12
Hydrogen Ion (ppb)	396	1	1995	66	173

* = no "L" or "B" Values

Table 2b. Correlation coefficients for unqualified soil data.

Ag	As	Cd	Cu	Mo	Pb	Sb	Zn	Hg	H+	
1.00	-0.02	0.16	0.06	-0.01	0.10	0.02	0.01	0.15	0.01	Ag
	1.00	0.31	-0.01	0.09	0.59	0.76	0.04	0.15	-0.04	As
		1.00	0.04	0.03	0.55	0.22	0.31	0.19	0.12	Cd
			1.00	0.38	0.09	0.00	0.34	0.15	0.17	Cu
				1.00	0.04	0.06	-0.09	-0.05	0.01	Mo
					1.00	0.59	0.59	0.24	0.04	Pb
						1.00	0.17	0.17	-0.03	Sb
							1.00	0.33	0.15	Zn
								1.00	0.13	Hg
									1.00	H+

Table 3. Results of partial-extraction analyses. "L" = less than lower limit of determination (table 1a).

Sample	Latitude	Longitude	Ag	As	Cd	Cu	Mo	Pb	Sb	Zn	Hg	Ht
1	38.183	105.824	L	3.3	0.250	22	0.85	13	L	33	10	32
2	38.183	105.823	L	3.4	0.170	19	0.84	11	L	34	20	16
3	38.185	105.822	L	3.4	0.120	16	0.70	10	L	31	10	22
4	38.186	105.821	L	3.2	0.250	20	0.81	14	L	37	10	28
5	38.187	105.819	L	3.8	0.180	19	0.86	12	L	32	10	50
6	38.188	105.818	L	2.5	0.170	24	1.00	10	L	42	10	32
7	38.189	105.816	L	3.7	0.230	26	0.91	15	L	37	10	112
8	38.191	105.815	3.90	1.1	0.220	20	0.36	10	L	16	50	45
9	38.192	105.814	0.16	3.2	0.380	20	0.72	36	L	46	20	18
10	38.193	105.813	0.55	3.1	0.260	19	1.50	11	L	35	20	5
11	38.187	105.840	0.92	2.9	0.200	30	0.94	13	L	40	20	18
12	38.189	105.839	0.22	3.0	0.220	33	0.88	12	L	43	10	45
13	38.190	105.837	0.37	2.9	0.260	37	0.95	14	L	49	20	224
14	38.191	105.836	0.07	2.8	0.250	30	0.91	13	L	44	10	71
15	38.192	105.834	0.07	2.9	0.240	33	1.20	13	L	50	10	45
16	38.193	105.833	0.08	2.9	0.230	31	1.10	13	L	48	10	40
17	38.194	105.832	0.12	3.0	0.240	33	0.94	13	L	46	20	40
18	38.195	105.830	L	3.1	0.290	32	1.00	15	L	47	20	79
19	38.196	105.829	L	3.1	0.220	23	0.89	12	L	41	10	79
20	38.197	105.828	L	2.9	0.150	22	0.94	11	L	40	10	1000
21	38.197	105.827	L	3.2	0.260	22	0.88	14	L	43	10	32
22	38.199	105.827	L	3.5	0.230	20	0.93	15	L	40	20	79
23	38.200	105.826	L	3.6	0.310	20	0.91	18	L	41	10	158
24	38.202	105.825	L	4.0	0.360	24	0.94	20	0.69	44	10	79
25	38.203	105.823	L	3.4	0.240	35	0.91	15	L	42	10	10
26	38.203	105.822	L	3.5	0.210	27	0.90	13	L	37	20	40
27	38.204	105.820	L	3.4	0.260	19	0.85	16	L	37	10	63
28	38.204	105.819	L	3.5	0.310	26	0.86	20	L	47	20	35
29	38.204	105.817	0.11	4.3	0.520	37	1.00	69	1.00	63	30	25
30	38.210	105.881	L	2.6	0.200	21	0.73	15	L	52	10	35
31	38.210	105.878	L	2.6	0.260	24	0.73	18	L	60	10	6
32	38.211	105.876	L	3.9	0.230	30	0.77	16	L	55	20	5
33	38.212	105.875	L	3.2	0.430	24	0.85	23	L	61	10	28
34	38.214	105.874	L	2.6	0.420	21	0.88	17	L	61	10	89
35	38.215	105.872	L	3.1	0.220	18	0.77	15	L	46	10	100
36	38.216	105.871	L	2.9	0.230	21	0.73	15	L	50	20	63
37	38.218	105.869	L	3.4	0.280	20	0.70	17	L	51	10	79
38	38.219	105.868	L	3.3	0.220	19	0.75	15	L	47	10	40
39	38.220	105.867	L	3.0	0.290	23	0.80	17	0.75	54	10	35
40	38.221	105.865	L	3.0	0.300	19	0.79	18	L	50	10	56
41	38.222	105.864	L	2.8	0.260	19	0.70	15	L	50	10	25
42	38.223	105.863	L	3.4	0.230	16	0.77	16	0.75	42	10	112
43	38.224	105.862	L	3.1	0.250	17	0.77	15	L	41	10	35
44	38.225	105.861	L	2.9	0.220	16	0.80	14	L	43	10	79
45	38.226	105.860	L	3.4	0.530	20	0.79	17	L	46	10	89
46	38.227	105.859	L	3.2	0.180	18	0.81	13	L	41	10	112
47	38.228	105.857	L	3.3	0.180	17	0.70	15	L	42	10	50
48	38.229	105.856	L	3.1	0.190	18	0.80	13	L	41	10	126
49	38.230	105.855	L	2.9	0.250	16	0.79	15	L	45	10	79
50	38.231	105.854	L	3.4	0.470	19	0.83	21	L	55	10	32
51	38.235	105.854	0.11	4.1	0.360	23	0.85	28	0.68	53	10	32

Table 3. Results of partial-extraction analyses. "L" = less than lower limit of determination (table 1a).

Sample	Latitude	Longitude	Ag	As	Cd	Cu	Mo	Pb	Sb	Zn	Hg	H+
52	38.235	105.856	L	4.0	0.270	21	0.92	19	L	52	10	71
53	38.236	105.857	0.07	3.9	0.350	22	0.77	23	L	53	10	63
54	38.236	105.859	0.13	4.2	0.410	28	0.75	32	0.88	60	10	13
55	38.237	105.861	L	3.8	0.320	23	0.72	23	L	52	10	32
56	38.237	105.862	0.12	4.0	0.550	27	1.20	29	0.79	71	10	1995
57	38.238	105.864	0.10	4.7	0.280	22	0.72	16	L	48	20	14
58	38.239	105.865	L	3.7	0.240	19	0.76	19	L	47	10	45
59	38.239	105.867	0.16	3.9	0.400	32	0.72	28	1.50	64	10	14
60	38.240	105.869	L	3.1	0.310	26	0.91	18	L	62	10	25
61	38.241	105.871	0.08	3.7	0.390	25	0.74	20	L	63	80	14
62	38.241	105.873	0.08	3.0	0.350	29	0.86	21	L	68	10	14
63	38.192	105.981	L	2.5	0.130	27	0.43	13	L	63	10	7
64	38.193	105.981	L	3.2	0.320	30	0.57	21	L	110	10	8
65	38.194	105.982	L	3.5	0.290	18	0.73	21	L	67	10	35
66	38.194	105.980	L	3.5	0.230	20	0.62	17	L	65	10	6
67	38.183	105.979	L	3.4	0.290	16	0.67	19	0.73	52	20	35
68	38.196	105.978	L	2.8	0.340	20	0.86	16	L	75	20	71
69	38.197	105.977	L	2.8	0.380	20	0.84	18	L	78	10	112
70	38.198	105.976	L	3.4	0.310	18	0.80	18	L	68	10	112
71	38.198	105.974	L	3.0	0.280	17	0.72	19	L	64	10	18
72	38.198	105.973	L	3.3	0.230	20	0.70	16	0.77	63	20	25
73	38.198	105.971	L	3.2	0.340	18	0.67	18	L	73	10	40
74	38.199	105.969	L	3.5	0.220	20	0.58	15	L	62	10	8
75	38.200	105.968	L	3.5	0.370	17	0.64	17	L	59	10	89
76	38.201	105.967	L	4.0	0.200	19	0.49	13	L	62	20	56
77	38.202	105.965	L	2.6	0.460	17	0.71	15	L	58	10	9
78	38.203	105.964	L	2.6	1.100	19	0.75	18	L	65	10	126
79	38.204	105.962	L	5.2	0.470	19	0.70	23	L	78	10	10
80	38.205	105.961	L	2.7	0.440	18	0.70	19	L	60	10	63
81	38.206	105.959	L	2.3	0.220	22	0.67	15	L	74	40	20
82	38.207	105.959	L	2.2	0.280	20	0.69	16	L	70	30	32
83	38.208	105.957	L	2.5	0.330	21	0.61	18	L	87	30	25
84	38.209	105.956	L	1.9	0.240	21	0.64	15	L	79	20	50
85	38.209	105.954	L	2.7	0.150	19	0.56	15	L	71	30	10
86	38.209	105.952	L	1.8	0.210	25	0.47	15	L	83	20	8
87	38.210	105.949	L	2.2	0.240	27	0.37	18	L	87	30	7
88	38.209	105.947	L	2.0	0.360	16	0.67	20	L	69	20	18
89	38.209	105.945	L	1.5	0.200	16	0.62	19	L	66	30	35
90	38.209	105.943	L	1.6	0.310	15	0.64	24	L	94	20	32
91	38.189	105.940	L	1.9	0.200	21	0.65	24	L	86	40	8
92	38.189	105.937	L	2.2	0.140	27	0.56	15	L	100	30	11
93	38.189	105.935	L	2.0	0.360	21	0.71	19	L	90	10	22
94	38.189	105.933	L	2.4	0.260	23	0.70	17	L	96	20	10
95	38.189	105.931	L	1.9	0.180	21	0.47	14	L	96	10	13
96	38.189	105.929	L	2.2	0.250	23	0.65	21	L	97	30	16
97	38.189	105.927	L	2.4	0.280	21	0.70	18	L	92	40	45
98	38.188	105.925	L	2.1	0.085	21	0.66	18	L	91	20	14
99	38.189	105.923	L	1.9	0.062	19	0.62	19	L	85	30	13
100	38.189	105.922	L	2.4	0.130	24	0.65	22	L	95	30	11
101	38.189	105.920	L	2.1	0.450	16	0.75	18	L	85	30	40
102	38.188	105.918	L	2.4	0.150	19	0.77	22	L	91	30	18

Table 3. Results of partial-extraction analyses. "L" = less than lower limit of determination (table 1a).

Sample	Latitude	Longitude	Ag	As	Cd	Cu	Mo	Pb	Sb	Zn	Hg	H+
103	38.188	105.910	L	2.5	L	19	0.85	22	L	78	40	20
104	38.188	105.902	0.18	2.5	0.330	25	0.79	39	L	150	30	35
105	38.187	105.885	L	1.5	L	24	1.10	12	L	57	30	4
106	38.187	105.864	L	2.0	L	26	2.10	12	L	43	20	35
107	38.187	105.851	0.13	2.7	0.180	26	2.50	9	L	42	30	79
108	38.184	105.926	L	3.3	0.460	20	0.81	22	L	90	30	56
109	38.186	105.942	L	3.4	0.170	29	0.63	13	L	110	20	7
110	38.186	105.944	L	3.6	0.280	28	0.67	15	L	100	30	25
111	38.187	105.946	L	3.4	0.190	27	0.60	14	L	94	40	11
112	38.188	105.948	L	7.5	0.130	21	0.55	12	L	78	40	6
113	38.188	105.950	L	3.3	0.210	22	0.77	14	L	73	50	35
114	38.188	105.952	L	3.3	0.260	21	0.75	16	L	80	50	50
115	38.188	105.954	L	3.1	0.260	21	0.74	14	L	83	40	50
116	38.188	105.956	L	2.4	0.220	23	0.79	14	L	81	50	50
117	38.189	105.958	L	3.0	0.220	24	0.67	14	L	92	40	6
118	38.189	105.960	L	2.4	0.310	22	0.81	16	L	84	40	71
119	38.190	105.961	L	2.5	0.230	23	0.76	14	L	80	50	35
120	38.191	105.963	L	2.2	0.190	23	0.74	15	L	81	60	40
121	38.244	105.946	0.300	1.7	0.240	27	0.71	42	L	230	40	45
122	38.244	105.945	0.260	2.5	0.780	28	1.10	50	L	190	50	89
123	38.243	105.943	L	1.6	0.190	21	0.99	26	L	110	20	100
124	38.241	105.942	0.770	3.0	0.900	44	1.20	100	L	270	30	200
125	38.240	105.940	0.500	3.1	0.960	38	1.30	64	L	290	30	79
126	38.240	105.938	0.081	2.2	0.330	20	1.10	32	L	100	30	112
127	38.238	105.936	0.140	2.5	0.430	24	1.20	51	L	150	30	71
128	38.237	105.936	0.097	2.1	0.400	19	1.10	38	L	110	30	282
129	38.236	105.935	0.097	3.0	0.130	22	1.40	36	L	100	10	48
130	38.235	105.935	0.250	1.7	0.370	25	0.99	46	L	240	10	56
131	38.234	105.934	0.100	1.7	0.270	20	0.96	34	L	140	10	79
132	38.233	105.934	L	1.7	0.170	17	0.90	32	L	110	10	200
133	38.231	105.933	0.100	2.2	0.290	18	1.20	33	L	110	30	178
134	38.230	105.933	0.110	2.5	0.530	21	1.20	44	L	130	30	178
135	38.229	105.933	0.070	2.2	0.320	21	1.10	39	L	110	20	79
136	38.227	105.933	B	2.6	0.190	18	1.20	34	L	98	20	158
137	38.226	105.933	0.100	2.1	0.510	18	0.91	41	L	150	30	79
138	38.225	105.933	0.079	1.7	0.260	19	0.93	32	L	120	30	79
139	38.222	105.933	0.071	1.5	0.200	17	0.82	32	L	100	20	126
140	38.219	105.933	L	1.7	0.250	19	0.98	29	L	110	20	50
141	38.216	105.932	L	1.6	0.088	16	1.10	24	L	85	10	112
142	38.213	105.932	0.092	1.8	0.120	15	0.86	25	L	88	10	79
143	38.210	105.932	0.081	2.4	0.320	18	0.95	31	L	130	30	40
144	38.207	105.931	L	2.1	L	18	0.85	21	L	86	20	50
145	38.204	105.931	L	2.4	0.092	18	0.84	23	L	82	20	28
146	38.201	105.931	L	2.1	L	18	0.87	20	L	82	10	100
147	38.199	105.931	L	1.6	0.180	17	0.71	24	L	92	20	32
148	38.196	105.930	L	1.9	L	21	0.75	17	L	93	20	21
149	38.192	105.929	L	1.9	0.230	22	0.60	32	L	130	20	28
150	38.189	105.929	L	1.9	0.240	18	0.78	26	L	110	20	224
151	38.187	105.929	L	2.3	L	19	0.66	20	L	96	30	18
152	38.186	105.929	L	1.8	L	16	0.59	18	L	84	10	63
153	38.184	105.929	L	1.7	L	20	0.61	16	L	94	20	32

Table 3. Results of partial-extraction analyses. "L" = less than lower limit of determination (table 1a).

Sample	Latitude	Longitude	Ag	As	Cd	Cu	Mo	Pb	Sb	Zn	Hg	Ht
154	38.183	105.929	L	1.8	L	21	0.55	16	L	110	20	63
155	38.181	105.928	L	2.2	0.180	18	0.83	22	L	91	30	158
156	38.180	105.928	L	2.3	L	19	0.73	20	L	88	20	56
157	38.178	105.928	0.069	2.0	0.150	18	0.79	24	L	91	20	45
158	38.176	105.928	L	1.9	0.100	18	0.72	20	L	91	30	45
159	38.175	105.927	L	1.9	0.099	21	0.67	20	L	91	10	22
160	38.174	105.926	L	2.0	0.300	18	0.80	25	L	98	10	71
161	38.172	105.925	L	1.9	0.220	19	0.72	29	L	110	20	28
162	38.168	105.928	L	2.0	0.220	35	0.85	28	L	140	30	14
163	38.167	105.930	L	2.0	L	29	0.70	17	L	120	30	10
164	38.167	105.931	L	2.1	L	20	0.63	15	L	84	10	7
165	38.167	105.933	L	1.6	0.085	19	0.68	15	L	87	10	25
166	38.168	105.934	L	2.0	0.140	26	0.70	17	L	110	10	14
167	38.168	105.936	L	1.7	L	19	0.63	16	L	89	10	126
168	38.168	105.938	L	1.9	0.130	20	0.57	18	L	93	10	22
169	38.168	105.939	L	2.1	0.170	19	0.69	19	L	85	10	9
170	38.168	105.941	L	2.2	L	20	0.65	17	L	84	10	9
171	38.169	105.944	L	2.0	L	20	0.67	16	L	83	20	16
172	38.173	105.970	L	2.0	0.130	16	0.64	26	L	150	20	158
173	38.174	105.968	L	2.0	L	39	0.64	17	L	140	10	50
174	38.176	105.966	L	1.6	0.059	31	0.57	19	L	150	10	25
175	38.177	105.963	L	2.2	0.120	22	0.76	19	L	110	10	56
176	38.178	105.962	L	2.0	0.150	22	0.76	18	L	110	10	251
177	38.178	105.960	L	2.3	0.120	24	0.73	19	L	120	20	126
178	38.178	105.959	L	2.8	0.120	24	0.75	21	L	110	30	22
179	38.177	105.958	L	2.5	L	27	0.77	17	L	120	10	25
180	38.177	105.957	L	2.1	0.077	28	0.66	16	L	110	20	45
181	38.176	105.956	L	1.9	0.055	21	0.79	17	L	90	60	71
182	38.175	105.955	L	2.0	L	23	0.83	16	L	100	30	100
183	38.174	105.953	L	1.9	0.150	22	0.74	20	L	110	20	22
184	38.174	105.951	L	1.9	L	22	0.77	14	L	95	20	40
185	38.173	105.949	L	2.1	0.120	22	0.88	18	L	99	20	112
186	38.173	105.946	L	1.8	L	21	0.64	15	L	85	20	71
187	38.172	105.945	L	1.8	L	20	0.80	16	L	84	10	45
188	38.221	105.944	0.076	1.5	0.400	21	0.93	34	L	150	30	40
189	38.221	105.946	0.097	1.6	0.420	22	0.99	35	L	170	20	71
190	38.221	105.947	0.087	1.7	0.470	22	0.95	35	L	160	20	63
191	38.221	105.949	L	2.1	0.210	19	1.10	25	L	110	20	141
192	38.221	105.951	0.083	2.2	0.310	22	1.10	33	L	130	30	45
193	38.221	105.953	0.190	2.1	0.430	27	1.00	38	L	150	20	40
194	38.221	105.956	0.089	2.8	0.320	22	0.98	34	L	130	30	40
195	38.221	105.957	0.370	8.4	0.370	35	1.20	64	2.40	160	30	11
196	38.223	105.958	0.073	9.9	0.420	22	1.10	56	3.10	140	10	16
197	38.225	105.958	L	7.4	0.150	28	1.60	33	2.50	100	30	11
198	38.226	105.959	0.075	9.4	0.280	26	1.50	51	4.00	120	30	11
199	38.227	105.960	0.130	5.7	0.310	29	1.00	41	2.00	170	10	13
200	38.228	105.961	L	8.9	0.440	25	1.10	89	2.30	160	10	10
201	38.228	105.963	L	27.0	0.820	24	1.30	130	3.50	190	40	10
202	38.228	105.965	L	3.8	0.220	17	0.75	27	1.40	87	60	22
203	38.227	105.967	L	2.2	L	22	0.93	13	L	89	40	63
204	38.227	105.969	L	2.2	0.260	20	0.76	17	L	96	40	1000

Table 3. Results of partial-extraction analyses. 'L' = less than lower limit of determination (table 1a).

Sample	Latitude	Longitude	Ag	As	Cd	Cu	Mo	Pb	Sb	Zn	Hg	H+
205	38.228	105.971	L	3.0	0.230	24	0.70	21	L	95	50	178
206	38.228	105.972	L	2.4	L	35	0.92	14	L	99	30	178
207	38.228	105.974	L	4.9	0.110	28	0.86	18	L	110	40	398
208	38.229	105.975	L	1.9	0.084	62	0.72	17	L	87	40	316
209	38.229	105.977	0.083	1.5	0.490	58	2.50	32	L	140	40	71
210	38.229	105.979	L	1.4	0.120	30	0.75	18	L	110	30	112
211	38.228	105.980	L	2.7	0.870	77	4.90	32	L	180	50	316
212	38.227	105.981	L	2.2	0.098	27	1.20	20	L	100	40	14
213	38.226	105.982	L	3.3	0.170	27	0.99	31	L	96	40	35
214	38.225	105.982	L	5.7	L	30	1.10	29	L	70	30	20
215	38.224	105.982	L	3.2	0.130	25	0.98	26	L	78	30	37
216	38.223	105.981	L	6.5	0.092	24	1.10	42	1.50	90	30	10
217	38.221	105.981	L	1.7	L	22	0.63	19	L	69	10	32
218	38.220	105.980	L	1.5	L	24	0.55	17	L	77	10	10
219	38.219	105.980	L	1.7	L	29	0.60	19	L	78	10	56
220	38.218	105.979	L	1.3	L	32	0.58	19	L	74	10	25
221	38.216	105.979	L	2.0	0.160	28	0.75	23	L	89	30	100
222	38.215	105.979	L	1.9	0.080	21	0.77	18	L	86	30	35
223	38.214	105.980	L	1.1	L	24	0.43	17	L	87	50	56
224	38.213	105.983	L	L	L	18	0.44	16	L	85	10	100
225	38.212	105.985	L	1.1	L	22	0.51	23	L	78	20	13
226	38.211	105.986	L	2.1	0.100	21	0.73	20	L	88	10	21
227	38.209	105.988	L	2.7	0.150	21	0.72	23	L	83	10	10
228	38.221	105.978	L	4.9	0.250	29	1.20	41	1.50	110	10	4
229	38.221	105.976	L	4.3	0.100	22	0.98	35	1.00	84	10	6
230	38.220	105.975	L	4.4	0.059	20	0.90	30	L	77	10	7
231	38.220	105.973	L	9.6	0.370	17	1.00	59	2.30	100	40	6
232	38.220	105.970	L	9.5	0.260	15	0.82	91	1.40	110	30	5
233	38.219	105.968	L	4.3	0.110	19	0.68	29	L	81	10	5
234	38.219	105.966	L	4.3	0.088	18	0.70	24	1.50	78	30	4
235	38.220	105.963	L	3.5	0.150	16	0.71	25	1.00	68	30	4
236	38.219	105.962	L	4.3	0.084	21	0.80	23	1.60	76	50	6
237	38.220	105.960	L	10.0	0.150	18	0.91	32	3.00	89	50	4
238	38.220	105.959	L	8.8	0.350	18	0.95	42	2.20	110	30	3
239	38.221	105.959	L	8.9	0.250	19	0.96	52	2.40	120	40	4
241	38.199	105.968	L	1.9	0.150	20	1.10	20	L	96	30	468
242	38.198	105.966	L	2.0	L	29	0.69	18	L	85	20	17
243	38.198	105.963	L	2.2	0.230	20	0.77	22	L	97	30	204
244	38.198	105.962	L	2.6	L	22	0.57	15	L	71	10	10
245	38.198	105.960	L	2.2	0.051	21	0.71	18	L	97	30	6
246	38.198	105.958	L	2.0	0.260	24	0.71	20	L	110	10	14
247	38.198	105.956	L	2.0	0.071	20	0.75	18	L	89	30	32
248	38.198	105.954	L	1.8	0.180	20	0.78	18	L	95	10	32
249	38.199	105.952	L	2.2	0.190	20	0.97	18	L	91	20	50
250	38.198	105.950	L	1.6	0.200	26	0.64	21	L	140	10	35
251	38.198	105.948	L	1.6	L	28	0.49	17	L	130	10	18
252	38.198	105.947	L	1.5	L	33	0.57	17	L	140	10	28
253	38.197	105.943	L	1.6	0.160	24	0.67	21	L	120	10	22
254	38.196	105.942	L	1.6	L	36	0.56	17	L	150	10	10
255	38.186	105.992	L	1.6	L	36	0.62	17	L	160	20	56
256	38.188	105.991	L	1.5	0.260	25	0.58	29	L	120	20	20

Table 3. Results of partial-extraction analyses. "L" = less than lower limit of determination (table 1a).

Sample	Latitude	Longitude	Ag	As	Cd	Cu	Mo	Pb	Sb	Zn	Hg	Ht
257	38.188	105.989	L	1.1	0.180	25	0.68	24	L	130	10	50
258	38.189	105.987	L	1.6	L	30	0.55	13	L	130	10	11
259	38.190	105.985	L	1.5	0.170	23	0.73	23	L	130	20	63
260	38.190	105.984	L	1.4	L	31	0.61	22	L	130	40	631
261	38.191	105.982	L	1.1	L	33	0.44	15	L	160	30	25
262	38.179	105.963	L	1.8	L	47	0.48	16	L	200	30	200
263	38.180	105.964	L	2.3	0.094	27	0.67	22	L	130	30	32
264	38.180	105.966	L	2.4	L	25	0.71	15	L	110	20	32
265	38.181	105.968	L	2.0	0.052	42	0.54	18	L	160	10	20
266	38.182	105.971	L	1.6	L	32	0.53	15	L	150	10	56
267	38.183	105.972	L	2.2	0.180	28	0.68	23	L	130	30	35
268	38.184	105.975	L	1.3	0.070	31	0.59	18	L	140	10	178
269	38.184	105.978	L	1.7	0.350	35	0.93	40	L	140	60	1122
270	38.184	105.980	L	1.7	L	50	0.79	19	L	150	30	18
271	38.186	105.980	L	1.7	0.150	29	0.77	20	L	160	40	355
272	38.187	105.980	L	2.4	0.086	35	0.71	27	L	140	20	126
273	38.188	105.980	L	2.1	0.120	49	0.58	23	L	180	40	224
274	38.188	105.980	L	1.8	0.065	31	0.68	19	L	130	20	141
275	38.189	105.980	L	1.6	0.180	41	0.73	23	L	170	40	178
276	38.190	105.979	L	2.5	L	41	0.53	20	L	160	30	1912
277	38.192	105.979	L	1.9	L	28	0.62	17	L	120	30	178
278	38.189	105.940	L	1.5	0.220	21	0.75	25	L	100	40	25
279	38.189	105.937	L	1.4	0.320	19	0.84	23	L	100	10	63
280	38.189	105.935	L	1.5	0.170	25	0.71	20	L	120	20	56
281	38.189	105.933	L	1.8	0.130	21	0.84	19	L	100	20	50
282	38.189	105.931	L	1.6	L	22	0.67	16	L	110	10	32
283	38.189	105.929	L	1.6	0.230	19	0.86	25	L	97	30	100
284	38.189	105.928	L	1.3	0.160	20	0.68	20	L	99	10	16
285	38.189	105.925	L	1.4	0.072	23	0.70	19	L	95	10	11
286	38.189	105.923	L	1.2	0.160	17	0.75	18	L	83	10	28
287	38.189	105.922	L	1.2	0.190	19	0.85	21	L	90	10	25
288	38.144	105.828	L	1.7	L	25	1.00	14	L	49	10	28
289	38.149	105.835	L	1.6	L	23	0.96	17	L	51	10	32
290	38.154	105.839	L	1.6	L	19	1.50	15	L	49	10	79
291	38.158	105.845	L	1.9	L	23	1.90	10	L	40	10	79
292	38.158	105.854	L	2.1	L	21	1.50	13	L	42	10	45
293	38.130	105.864	0.170	1.6	L	22	0.65	11	L	35	10	4
294	38.148	105.902	L	L	0.320	28	0.45	39	L	150	10	18
295	38.148	105.904	0.071	L	0.180	19	0.54	25	L	120	10	2
296	38.148	105.906	L	L	0.280	25	0.65	29	L	130	10	7
297	38.148	105.908	L	1.4	0.140	17	0.81	18	L	77	10	10
298	38.148	105.910	L	1.3	0.160	18	0.75	19	L	81	20	9
299	38.148	105.912	L	1.1	L	14	0.61	13	L	55	10	22
300	38.148	105.914	L	1.6	0.072	17	0.70	16	L	74	30	20
301	38.148	105.916	L	1.5	L	19	0.71	15	L	80	10	8
302	38.148	105.919	L	1.7	0.170	22	0.90	20	L	92	30	22
303	38.148	105.921	L	1.7	0.210	22	0.82	21	L	86	20	9
304	38.148	105.923	L	1.5	0.100	20	0.74	23	L	84	30	9
305	38.252	105.951	0.420	5.3	0.200	28	0.93	54	1.90	120	30	10
306	38.252	105.954	L	6.0	L	22	0.85	22	L	77	10	11
307	38.252	105.956	0.069	2.8	0.099	22	0.98	26	L	79	10	10

Table 3. Results of partial-extraction analyses. "L" = less than lower limit of determination (table 1a).

Sample	Latitude	Longitude	Ag	As	Cd	Cu	Mo	Pb	Sb	Zn	Hg	Ht
308	38.251	105.958	0.080	3.3	0.150	24	0.82	22	L	74	30	9
309	38.251	105.960	0.076	2.7	0.310	22	0.84	27	L	90	30	9
310	38.251	105.962	0.110	3.2	0.190	23	0.84	24	L	83	30	9
311	38.251	105.963	L	2.9	0.200	24	0.91	31	L	87	30	8
312	38.250	105.965	L	3.2	0.160	23	0.93	21	L	79	20	8
313	38.250	105.967	L	1.9	L	23	0.87	17	L	75	30	8
314	38.249	105.968	L	2.0	0.180	23	0.88	23	L	83	10	7
315	38.248	105.970	L	3.0	L	23	0.80	15	L	70	30	8
316	38.247	105.971	L	2.0	0.091	20	0.93	22	L	71	10	11
317	38.247	105.973	L	2.6	0.170	21	0.91	25	L	78	10	6
318	38.246	105.975	L	2.6	0.110	22	0.87	22	L	75	10	6
319	38.246	105.977	L	2.6	0.180	22	0.98	25	L	79	10	4
320	38.245	105.978	L	2.2	0.091	21	0.93	21	L	75	10	13
321	38.244	105.980	L	2.2	0.120	22	0.96	23	L	79	10	9
322	38.244	105.982	L	2.9	L	22	0.85	17	L	65	20	10
323	38.243	105.984	L	2.6	L	19	0.84	19	L	63	10	8
324	38.243	105.986	L	3.2	L	18	0.78	19	L	61	10	8
325	38.242	105.987	L	1.9	0.280	18	1.20	20	L	79	10	16
326	38.242	105.988	L	2.1	0.280	19	1.00	23	L	84	10	16
327	38.242	105.990	L	2.3	0.290	18	0.88	25	L	77	10	11
328	38.241	105.992	L	2.3	0.220	16	0.97	26	L	69	10	50
329	38.241	105.992	L	2.8	L	20	0.91	19	L	65	20	9
330	38.241	105.993	L	3.0	0.061	19	1.20	22	L	74	10	10
331	38.241	105.996	0.310	2.1	0.320	18	1.10	30	L	85	10	119
332	38.240	105.998	0.097	2.4	0.130	21	1.10	26	L	90	10	25
333	38.240	105.998	L	1.8	L	19	0.95	19	L	77	10	11
334	38.240	105.999	L	2.3	0.190	18	0.97	21	L	83	20	7
335	38.240	106.000	L	2.7	0.150	19	1.00	20	L	80	10	6
336	38.240	106.002	L	3.7	L	19	0.89	18	L	63	30	8
337	38.239	106.005	L	4.1	L	17	0.85	17	L	84	20	7
338	38.239	106.008	L	3.8	L	20	0.83	17	L	72	30	7
339	38.238	106.010	0.120	4.3	L	21	1.00	22	L	93	20	6
340	38.238	106.013	L	2.7	0.092	18	0.95	22	L	120	10	6
341	38.237	106.014	L	3.3	0.094	19	0.92	20	L	76	30	6
342	38.236	106.016	L	3.3	L	23	0.85	17	L	64	20	6
343	38.235	106.017	L	2.7	L	21	0.85	18	L	82	20	3
344	38.158	105.882	L	2.0	L	21	0.97	13	L	52	10	18
345	38.159	105.864	L	2.1	L	22	1.50	12	L	45	10	2
346	38.157	105.882	L	1.8	L	21	1.00	11	L	55	10	1
347	38.156	105.882	L	1.7	L	17	1.00	9	L	38	10	2
348	38.155	105.882	L	1.6	L	17	1.00	8	L	37	10	2
349	38.153	105.882	L	1.9	L	14	0.91	6	L	31	10	1
350	38.151	105.882	L	1.7	L	13	0.85	6	L	24	10	3
351	38.150	105.882	L	1.9	L	16	0.92	8	L	31	10	2
352	38.148	105.882	L	2.0	L	18	0.93	9	L	45	10	6
353	38.147	105.882	L	1.7	0.130	24	1.10	18	L	71	50	4
354	38.145	105.883	L	1.4	L	17	0.87	14	L	47	10	7
355	38.144	105.882	L	1.8	L	21	0.85	22	L	67	10	6
356	38.130	105.883	L	2.2	L	33	1.00	14	L	70	30	16
357	38.129	105.828	L	1.7	L	18	0.69	16	L	59	10	10
358	38.185	105.822	L	2.0	L	18	0.73	12	L	39	10	79

Table 3. Results of partial-extraction analyses. "L" = less than lower limit of determination (table 1a).

Sample	Latitude	Longitude	Ag	As	Cd	Cu	Mo	Pb	Sb	Zn	Hg	Ht
359	38.184	105.820	L	2.5	L	17	0.90	14	L	42	30	40
360	38.183	105.819	L	2.7	L	24	1.00	14	L	45	20	25
361	38.182	105.818	L	2.9	L	21	0.91	13	L	40	10	63
362	38.181	105.816	L	2.4	L	18	0.86	14	L	51	10	32
363	38.180	105.815	L	2.9	L	27	1.00	15	L	49	10	247
364	38.180	105.812	L	2.6	L	56	5.20	15	L	46	10	20
365	38.179	105.812	L	2.6	L	36	3.70	12	L	53	10	20
366	38.178	105.811	L	2.4	L	16	1.30	10	L	39	10	16
367	38.177	105.809	L	2.7	L	21	2.00	15	L	48	10	32
368	38.176	105.809	L	2.9	L	30	4.30	13	L	47	10	10
369	38.174	105.809	L	3.1	L	30	4.40	12	L	47	10	13
370	38.173	105.809	L	2.5	L	20	1.30	14	L	51	10	22
371	38.172	105.808	L	3.1	0.110	18	1.10	18	L	48	10	32
372	38.170	105.807	L	1.9	L	26	1.20	12	L	55	10	25
373	38.169	105.807	L	2.2	0.054	22	0.87	13	L	55	10	11
374	38.167	105.809	L	2.2	L	25	0.87	12	L	55	10	16
375	38.165	105.809	L	2.9	L	20	0.65	9	L	42	10	11
376	38.164	105.808	L	2.5	0.056	20	0.73	17	L	52	10	6
377	38.163	105.808	0.140	3.8	L	66	1.20	21	L	60	10	6
378	38.161	105.808	L	2.6	L	23	0.67	9	L	52	10	14
379	38.160	105.808	L	2.3	L	22	0.84	10	L	52	10	8
380	38.158	105.808	L	2.7	L	21	0.83	13	L	53	10	25
381	38.157	105.808	L	2.4	L	25	0.96	14	L	47	10	16
382	38.155	105.808	L	2.8	L	35	1.40	17	L	61	10	13
383	38.154	105.808	L	2.3	L	29	1.20	15	L	58	10	11
384	38.153	105.808	L	3.1	L	34	1.20	16	L	62	10	8
385	38.151	105.808	L	2.9	L	38	1.30	18	L	71	10	9
386	38.149	105.808	L	2.8	L	33	1.20	15	L	62	10	20
387	38.148	105.808	L	2.5	L	30	1.20	17	L	60	10	20
388	38.147	105.808	L	3.0	L	35	1.40	17	L	63	10	9
389	38.146	105.810	L	2.4	L	32	1.10	18	L	64	10	10
390	38.144	105.811	L	1.9	L	24	0.90	16	L	59	10	11
391	38.144	105.818	L	2.5	L	26	0.99	13	L	51	10	82
392	38.192	105.813	0.770	1.3	0.110	29	0.80	12	L	40	20	28
393	38.189	105.845	0.130	1.9	L	24	2.40	10	L	44	10	22
394	38.189	105.855	L	2.2	L	27	2.30	11	L	46	10	40
395	38.189	105.863	0.083	2.4	0.110	33	3.10	13	L	60	10	8
396	38.189	105.873	L	1.7	L	22	1.40	10	L	45	10	6
397	38.189	105.883	0.078	2.2	0.061	36	3.00	13	L	77	10	160

Table 4. Analysis of sinters.

Element	Mineral Hot Springs *	Valley View Hot Springs
Al (%)	0.14	0.76
Ca (%)	40	38
Fe (%)	0.55	0.38
K (%)	0.07	0.30
Mg (%)	0.91	0.70
Na (%)	0.06	0.09
P (%)	0.01	0.03
Ti (%)	0.007	0.02
Mn (ppm)	370	120
Ag (ppm)	<2	6
As (ppm)	49	<10
Au (ppm)	<8	<8
Ba (ppm)	240	320
Be (ppm)	6	<1
Bi (ppm)	<10	<10
Cd (ppm)	<2	<2
Ce (ppm)	<4	7
Co (ppm)	2	8
Cr (ppm)	1	6
Cu (ppm)	3	6
Eu (ppm)	<2	<2
Ga (ppm)	<4	<4
Ho (ppm)	<4	<4
La (ppm)	3	5
Li (ppm)	23	3
Mo (ppm)	<2	<2
Nb (ppm)	<4	<4
Nd (ppm)	10	15
Ni (ppm)	<2	7
Pb (ppm)	<4	<4
Sc (ppm)	<2	<2
Sn (ppm)	<5	<5
Sr (ppm)	1400	730
Ta (ppm)	<40	<40
Th (ppm)	<4	<4
U (ppm)	<100	<100
V (ppm)	<2	8
Y (ppm)	<2	3
Yb (ppm)	<1	<1
Zn (ppm)	6	29
Hg (ppm)	0.13	0.07

* Collected by A.J. Gallagher (U.S. Geological Survey, Branch of Geophysics)

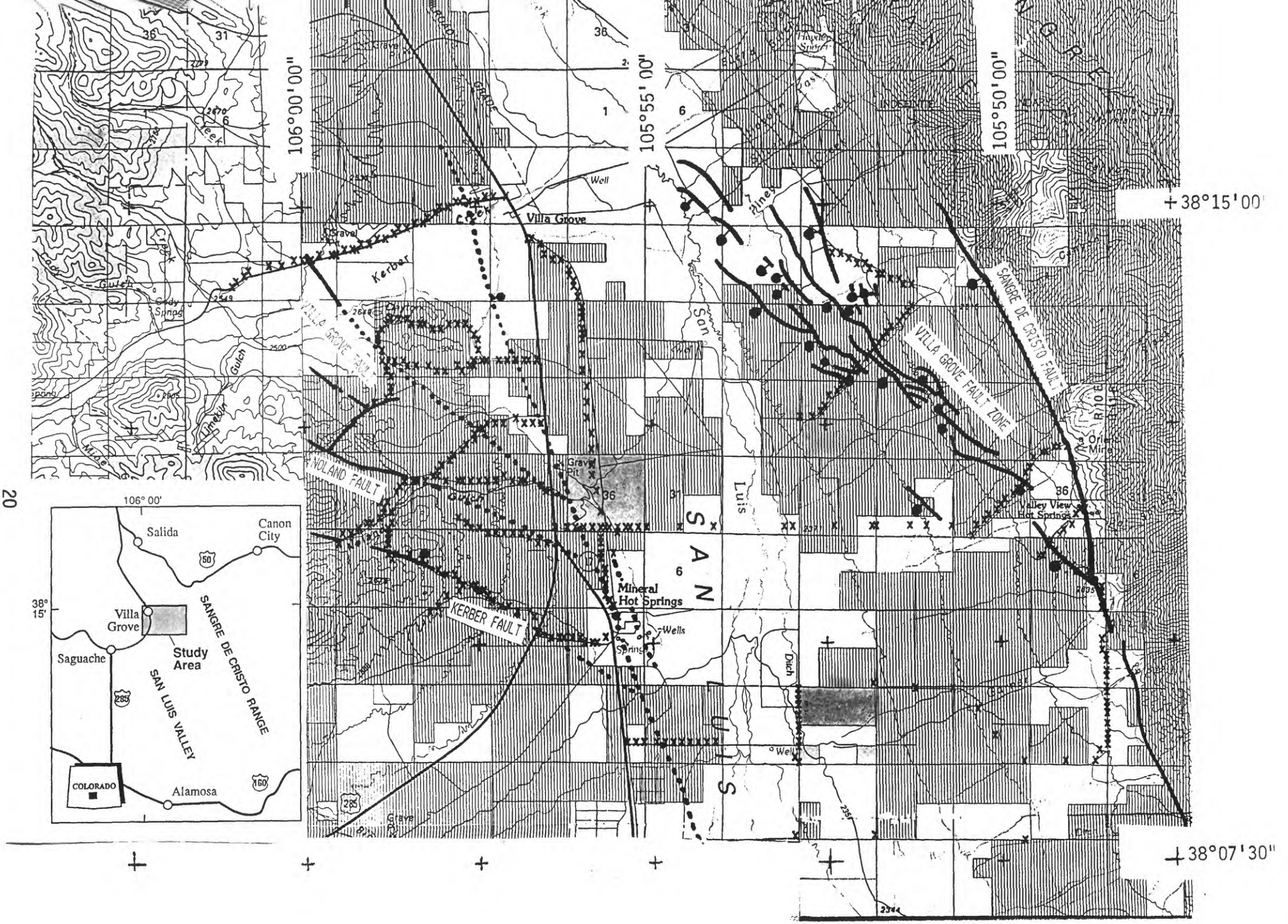

Fig. 1. Soil-sample locations.

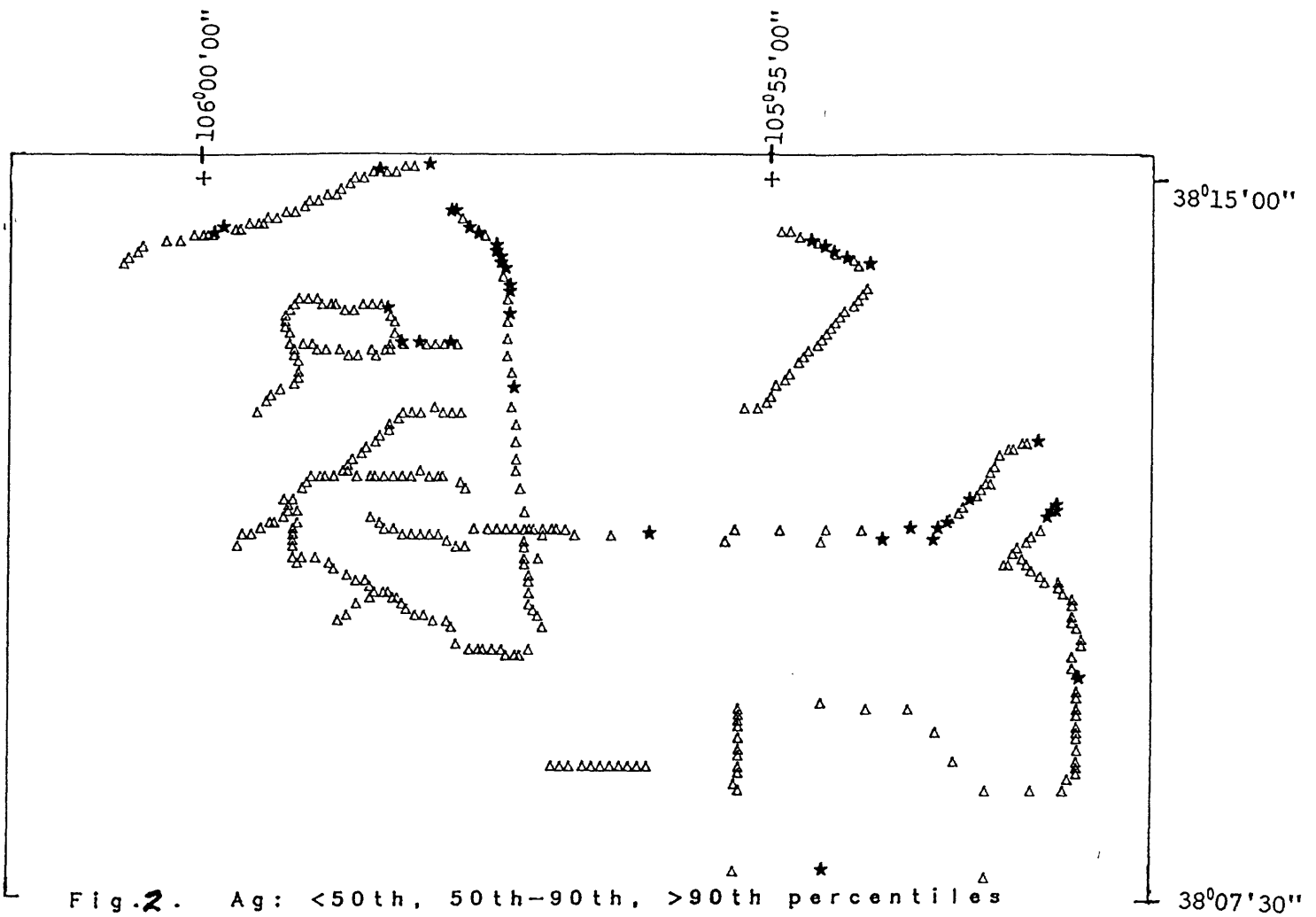

Fig.2. Ag: <50th, 50th-90th, >90th percentiles

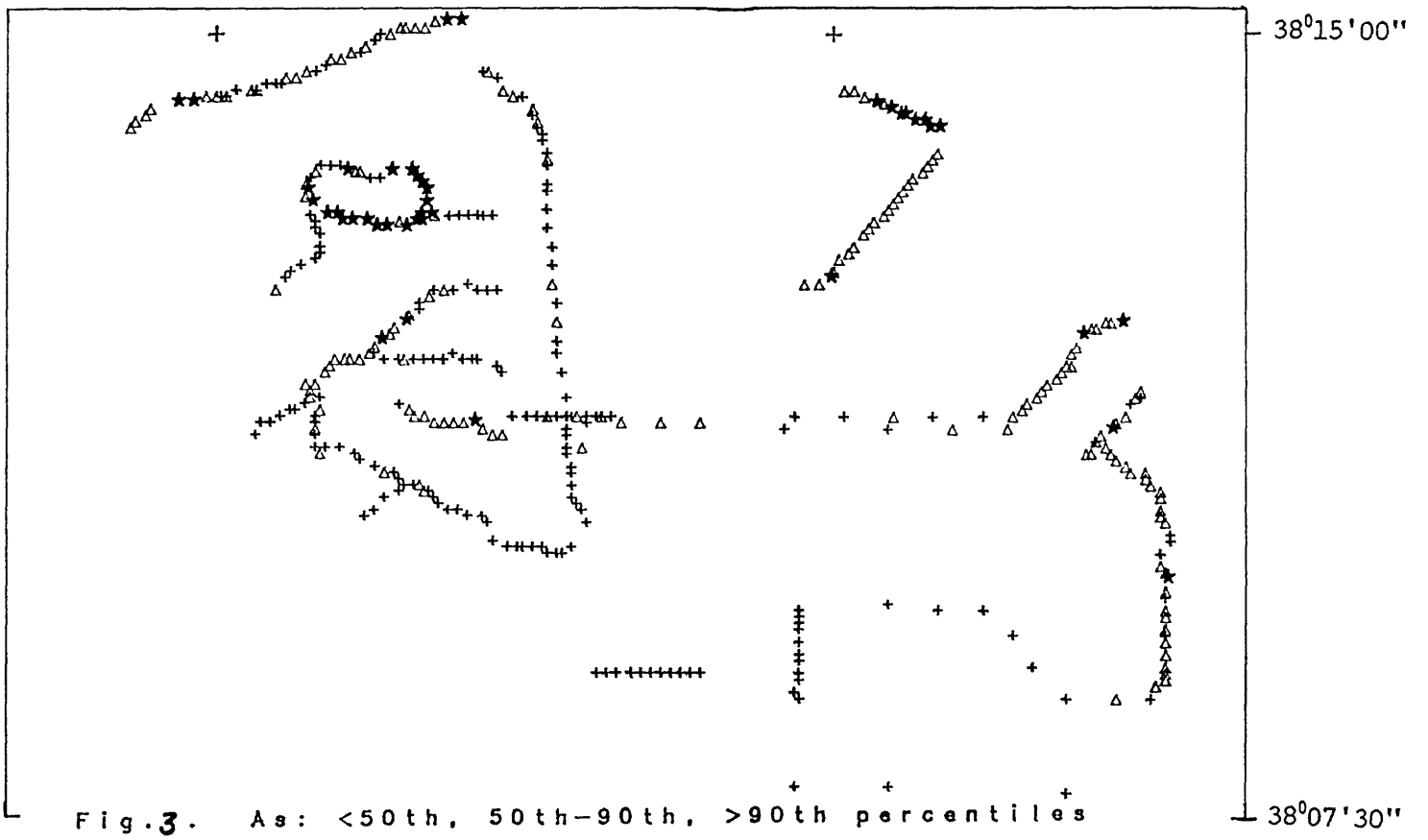

Fig.3. As: <50th, 50th-90th, >90th percentiles

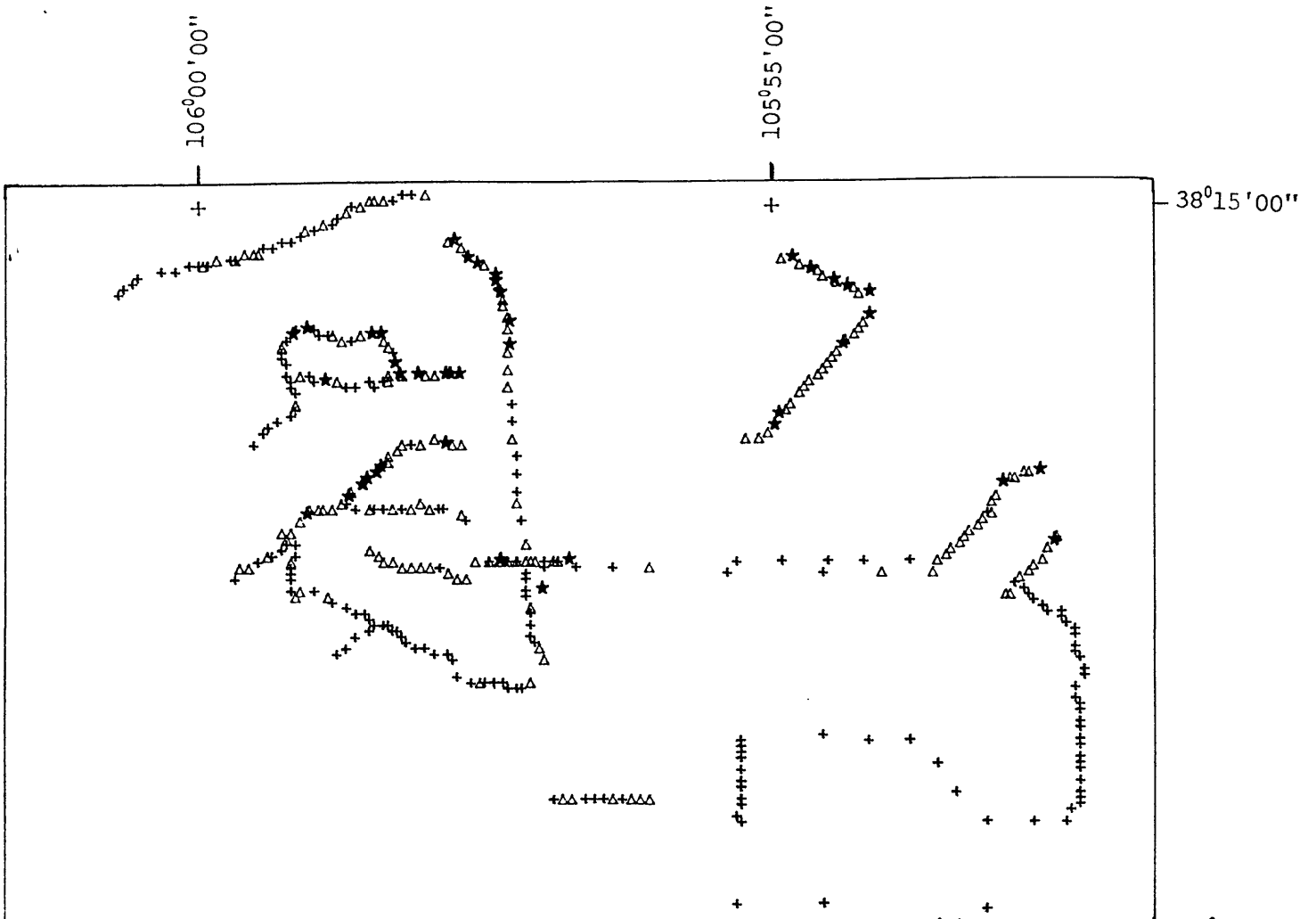

Fig. 4. Cd: <50th, 50th–90th, >90th percentiles

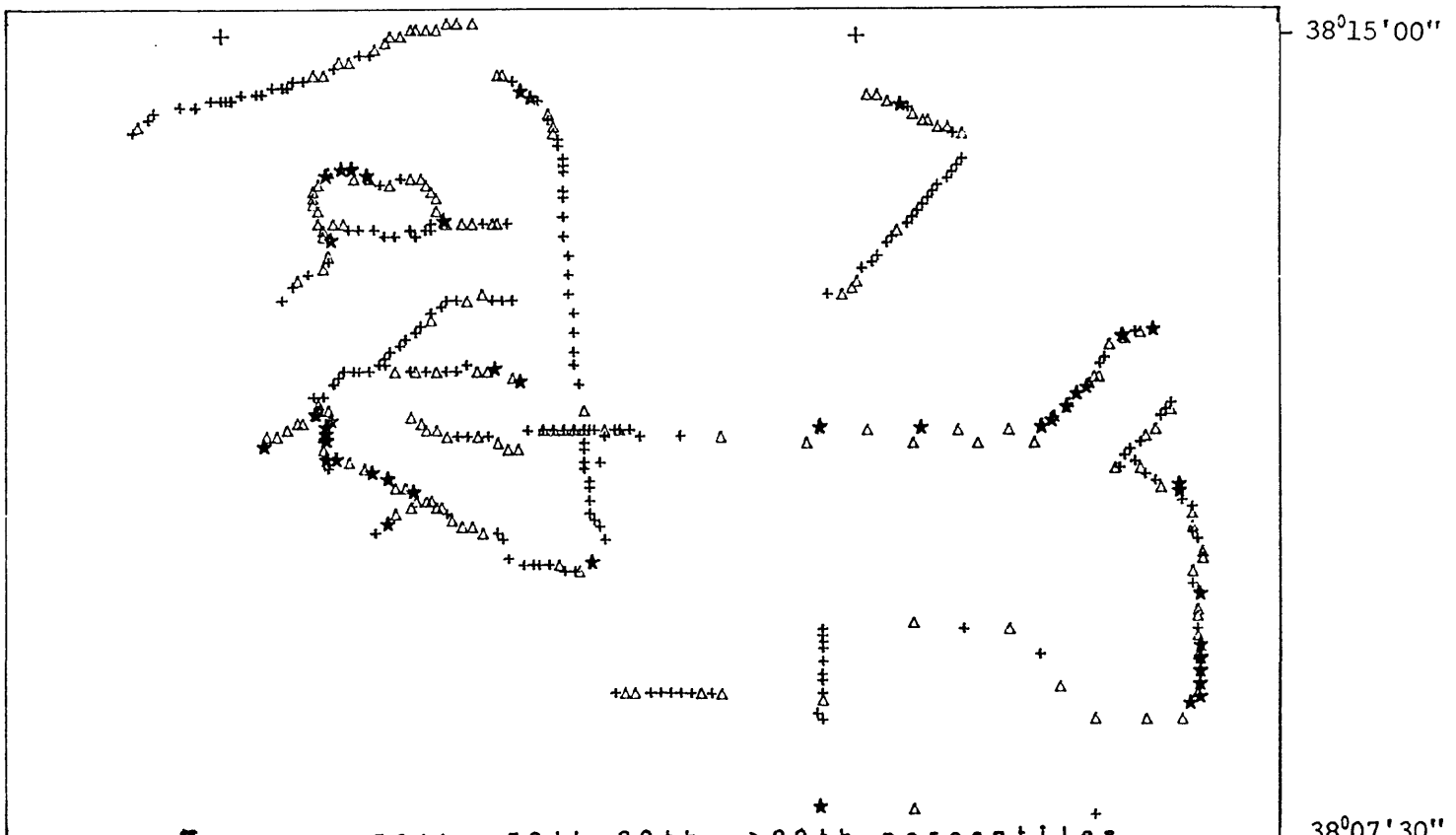

Fig. 5. Cu: <50th, 50th–90th, >90th percentiles

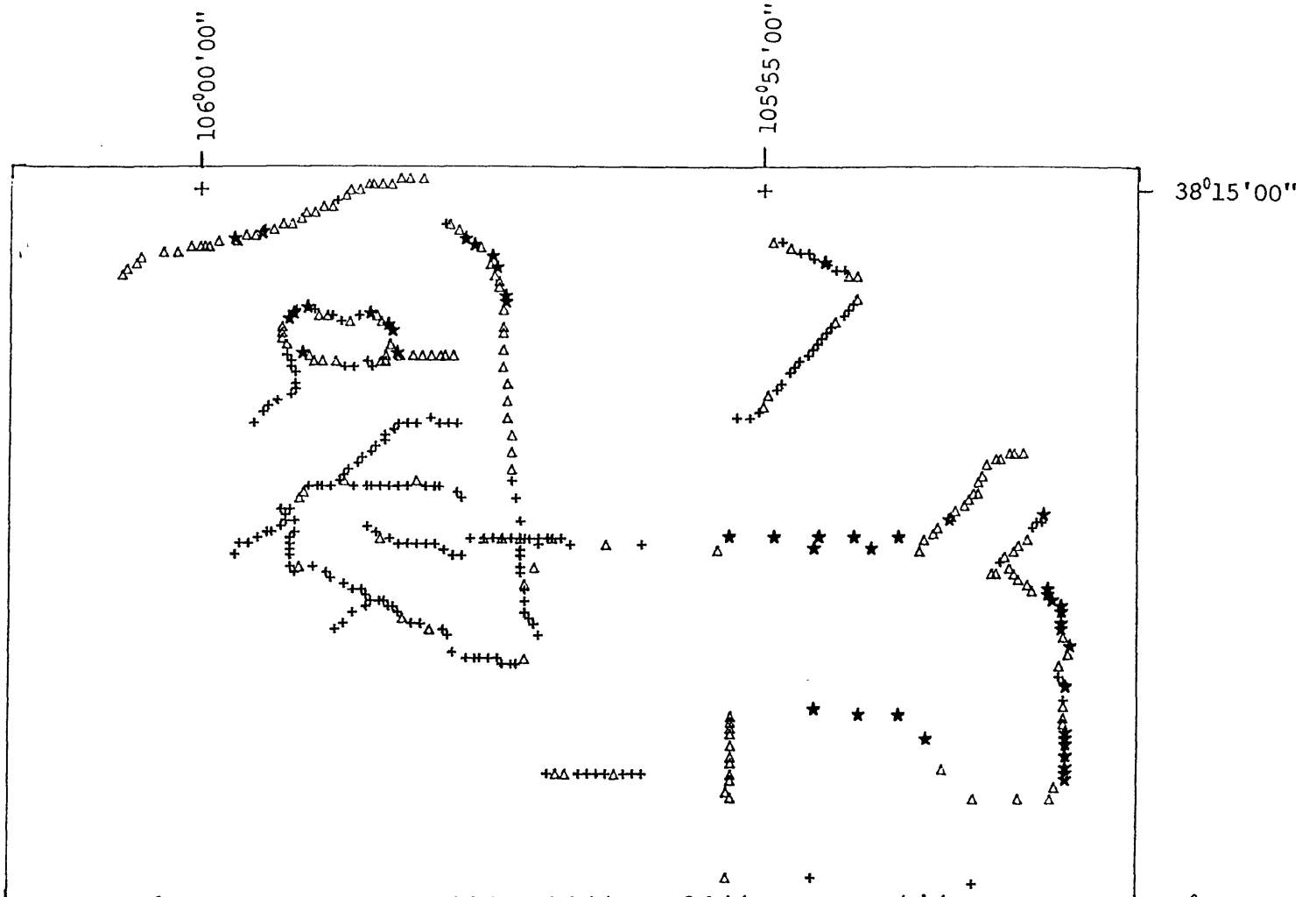

Fig. 6. Mo: <50th, 50th–90th, >90th percentiles

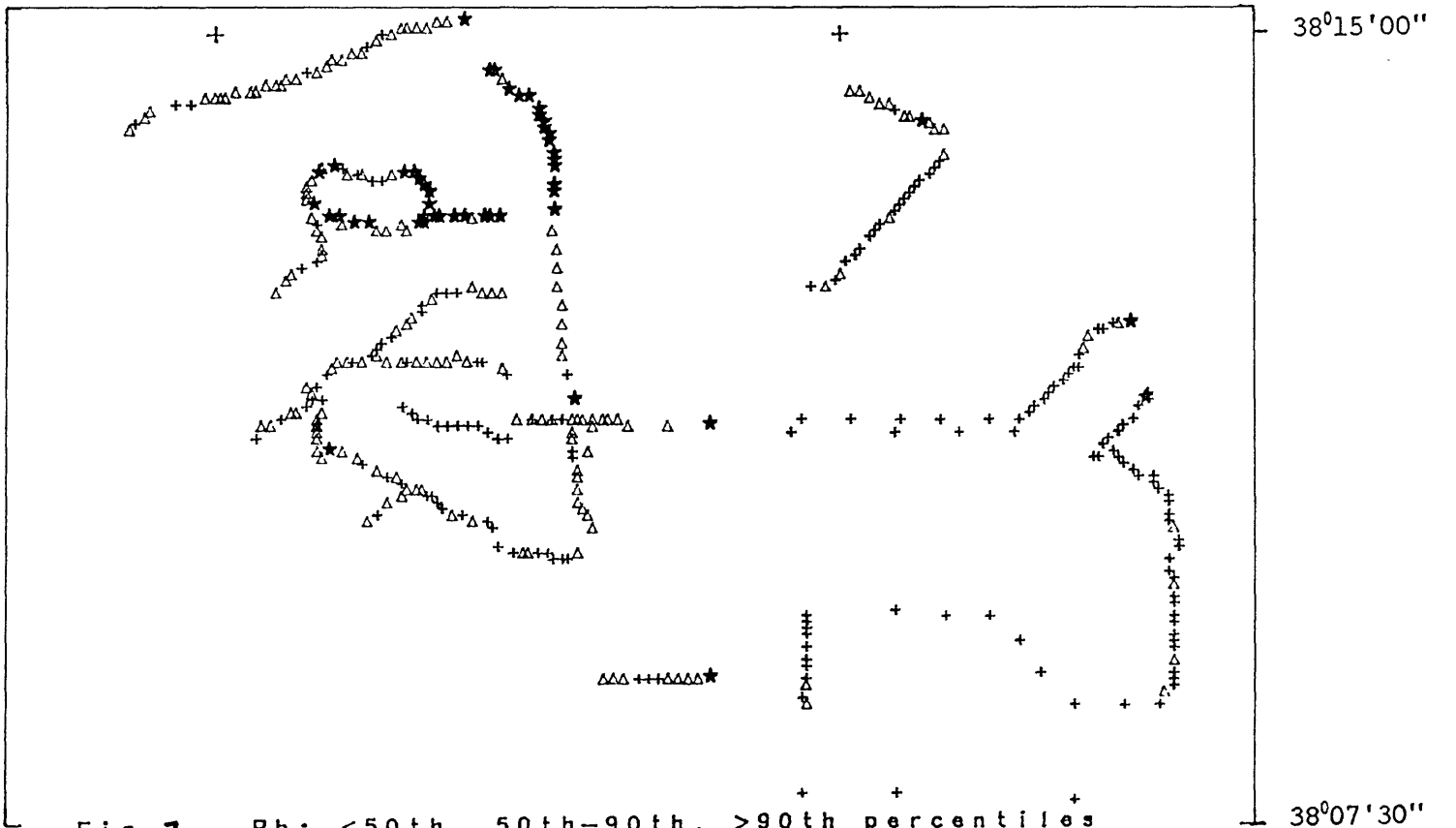

Fig. 7. Pb: <50th, 50th–90th, >90th percentiles

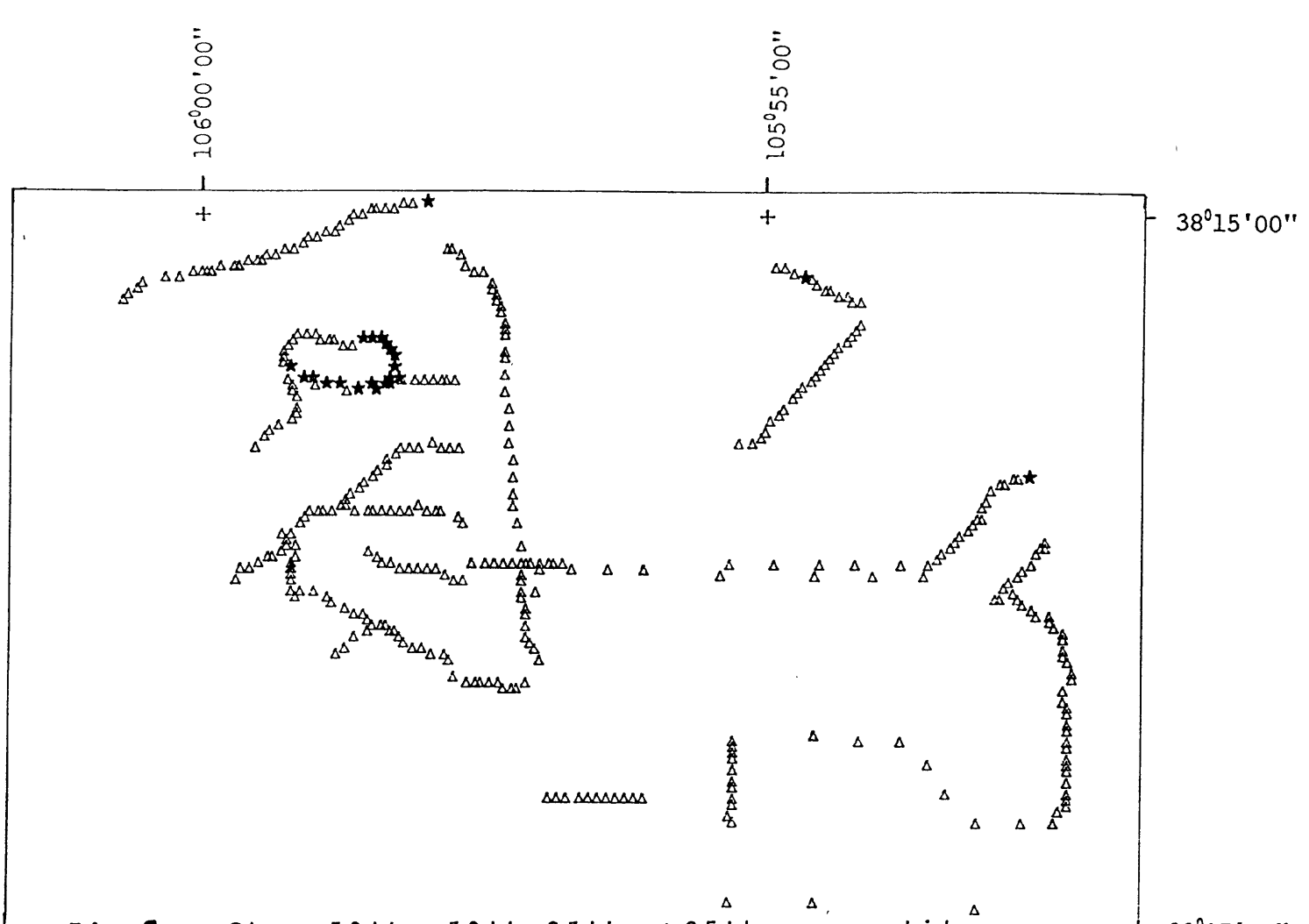

Fig.8. Sb: <50th, 50th–95th, >95th percentiles

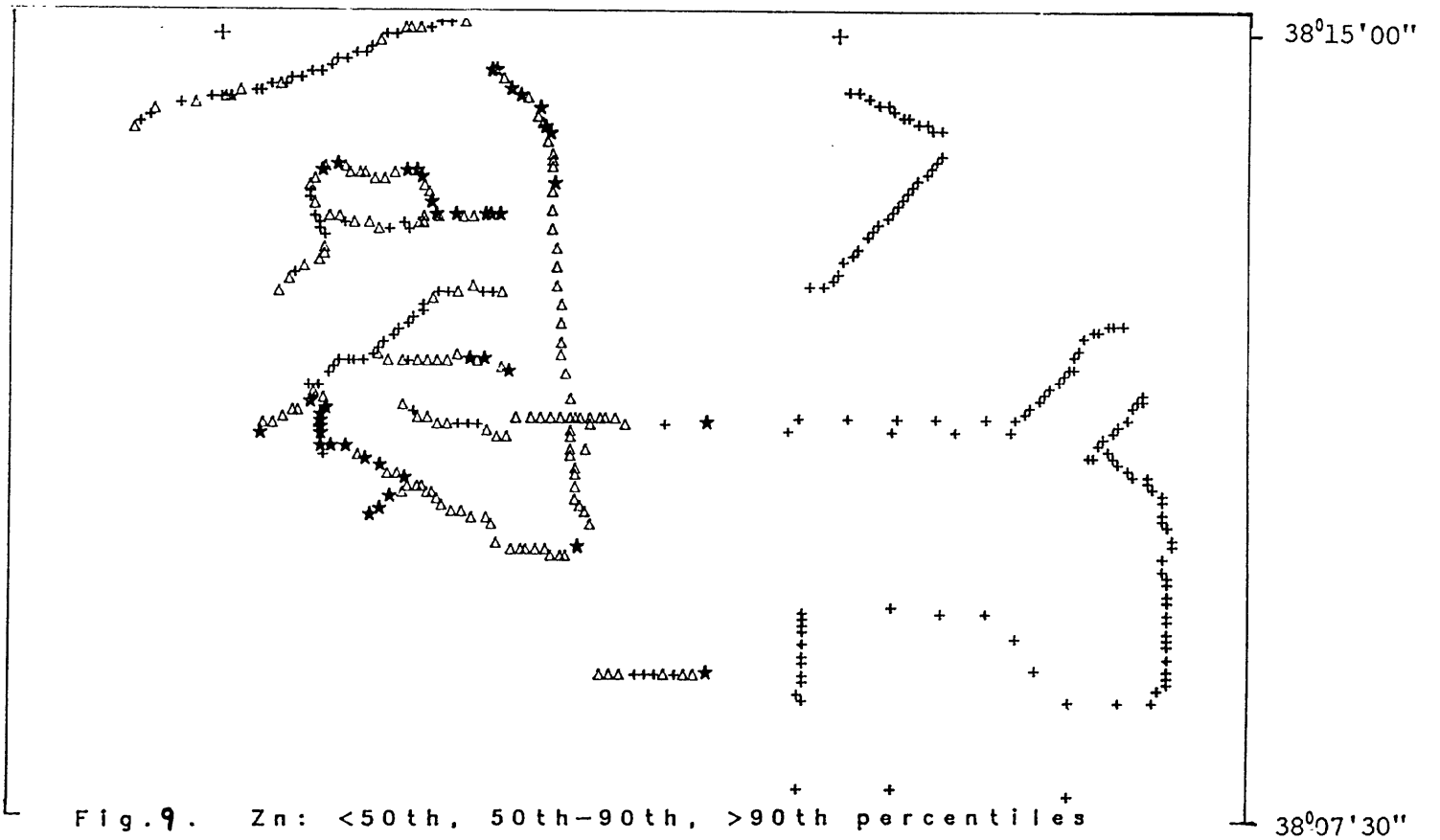

Fig.9. Zn: <50th, 50th–90th, >90th percentiles

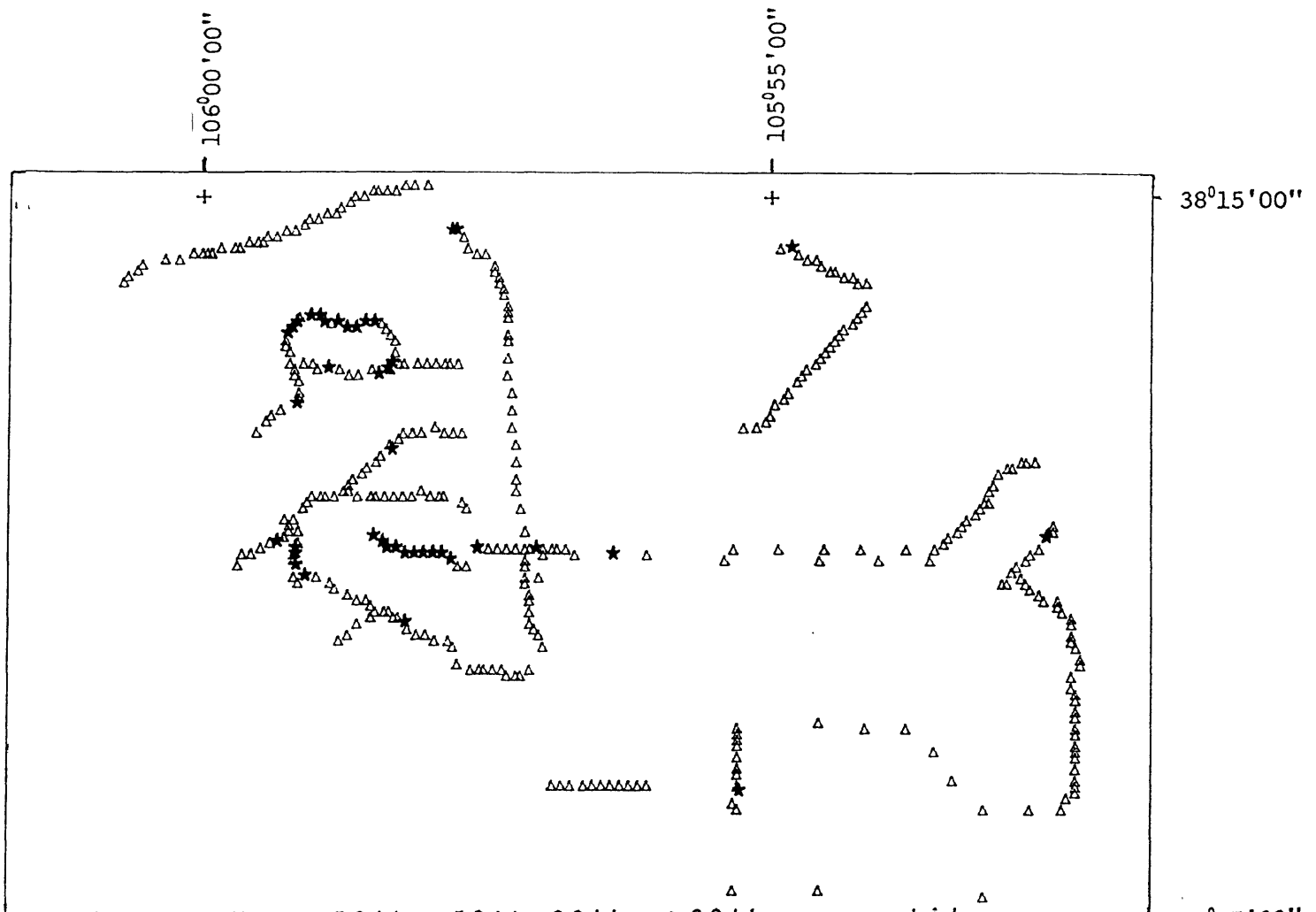

Fig.10. Hg: <50th, 50th–90th, >90th percentiles

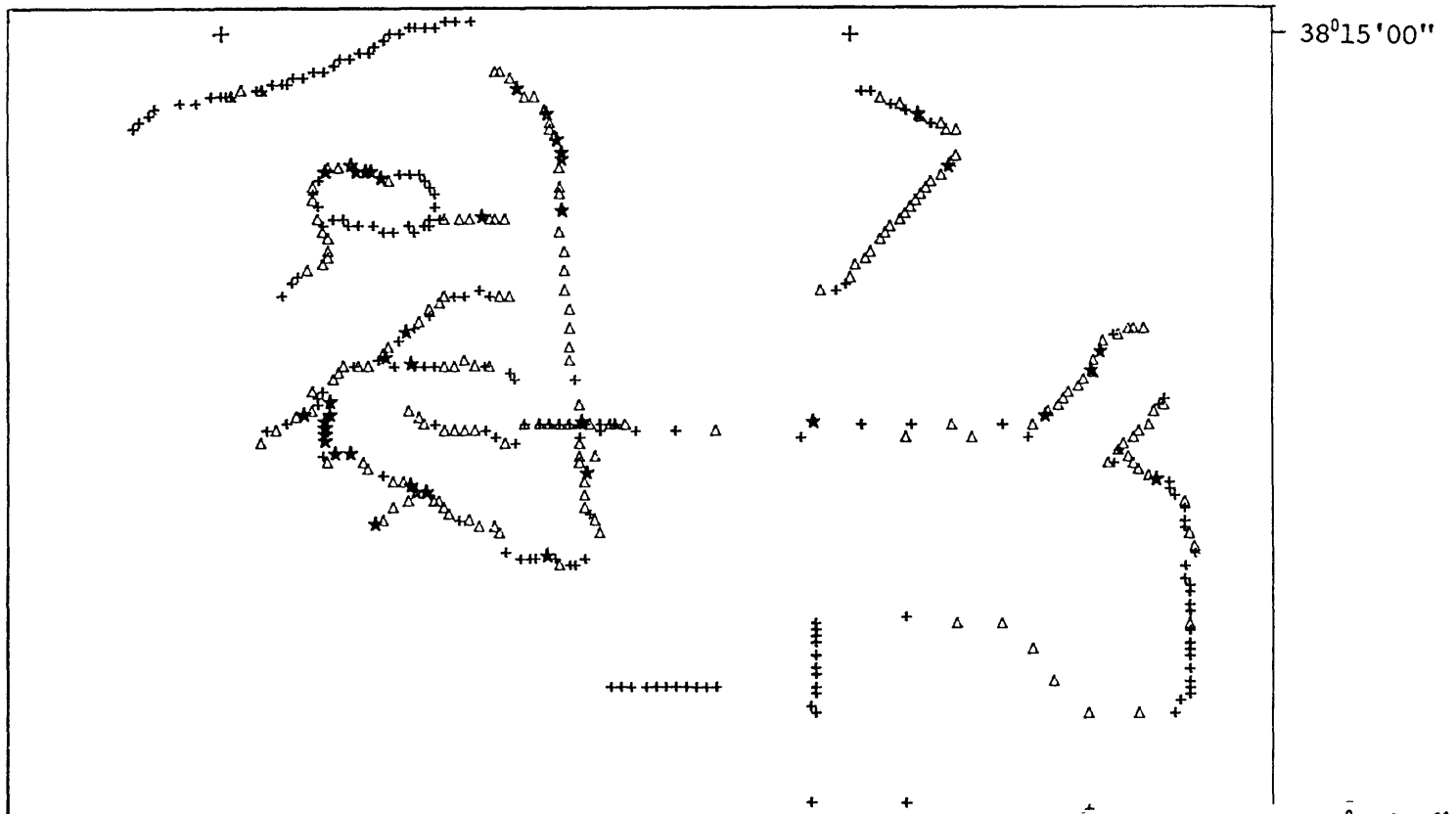

Fig.11. Hydrogen Ion: <50th, 50th–90th, >90th percentiles