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Item 13

SOIL SAMPLING OF THE ESTELLA VEIN
A geochemical orientation study

Betty O'Neal Silver Mine, Inc.

Lander County, Nevada

by

Anthony L. Payne

April 1965

ANTHONY L. PAYNE mining geologist

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April 25, 1965

Mr. Clayton T. McNeil, E.M.
Betty O'Neal Silver Mine, Inc.
622 Bank of America Building
300 Montgomery Street
San Francisco, California

Dear Mr. McNeil:

It is a pleasure to submit herewith five copies of a report on the soil geochemistry of the Estella vein area on the properties of Betty O'Neal Silver Mine, Inc., Sec. 23, T. 30 N., R. 45 E., Lander County, Nevada.

This geochemical project was outlined in a letter proposal to Mr. Douglas R. Ketron dated April 9, 1965. In going over the analytical results with Mr. Ketron on April 24, 1965, it was decided not to determine bismuth, in order to get the report to you as quickly as possible. There will be no need to run the samples for bismuth, as several other elements are more sensitive, require less tedious analytical methods, and show promise as geochemical indicators of ore on the Betty O'Neal ground. Cold copper was run for comparative purposes, although this was not included in the original proposal.

Analytical results indicate that silver, total heavy metals (lead, zinc, and copper), manganese, and antimony are present in anomalous amounts in soil over the Estella vein suboutcrop. A geochemical evaluation of the soil over other Betty O'Neal property is recommended. Total heavy metal is proposed as a reconnaissance method for samples collected on 100-ft. centers, followed by silver sampling in detail to pin-point exploration targets. This approach has the inherent advantage that any targets that develop must of necessity lie quite close to the surface. Consequent ease of exploration and development naturally engenders enthusiasm for the simplicity of the proposal.

Alternative methods to accomplish the program are outlined. An estimate of costs is furnished in separate letter.

If I can be of any help with questions you may have concerning this report, please do not hesitate to call upon me.

Yours very truly,

Anthony L. Payne
Mining Geologist

ALP:sk

Enclosures - 5 copies of report
estimate of cost of geochemical project

SOIL SAMPLING OF THE ESTELLA VEIN

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Introduction

A major difficulty in applying geochemical exploration methods to a new area is the lack of knowledge concerning the behavior of the ore and gangue elements in the complex sequence of chemical and mechanical processes which attend weathering. Theoretical data may be used in predicting the general behavior of ore and gangue elements during weathering, but soil sample geochemical prospecting techniques demand a more exact knowledge of the content of the elements known or suspected to be of importance in prospecting. Furthermore, an idea should be gained of the configuration of the anomaly, that is, its size (area and amplitude), shape, homogeniety, etc. Orientation studies are the most straightforward means of obtaining these data.

The idea of an orientation study in the Betty O'Neal Mine area is particularly inviting, for the hypogene ores are complex, little is known of the nature of the oxidized zone, and large areas around the productive area, although known to contain geologic conditions permissive to ore deposition, are covered by soil: hence inadequately prospected.

A general consideration in proposing a thorough soil sample orientation study is that the behavior of silver and copper during weathering is particularly difficult to predict. Both elements are members of the "copper group", and may either form stable oxidized compounds near the surface, or be unstable and be leached completely from the surficial zone by downward percolating ground water.

With these thoughts in mind, a letter proposal for a thorough geochemical orientation was made April 9, 1965, and approved by Mr. Clayton T. McNeil over the telephone April 12, 1965. The samples were collected by Mr. Douglas R. Katron of Betty O'Neal Silver Mine's staff during mid-April. They were received at the writer's laboratory in Reno on April 15, and were analysed during the week April 18-23rd.

As outlined in the original proposal, the Estella vein area was selected for the suite of orientation samples. The Estella vein was known to have come through to the surface, where it underwent oxidation and contributed material to the soil profile directly. The surface conditions at the Estella vein outcrop area were less disturbed than over other ore shoots. Also, the position of the Estella vein is known with certainty, which is not the case with other ore deposits in the area.

One hundred sample sites were laid out on 100-ft. spacing on a grid 900 x 900 ft. square centering over the caved stopes on the Estella vein. Samples were not collected at four of the sample sites; Nos. 15, 43, 70, and 71, because of obvious contamination or inaccessibility of soil. Analysis of the sample suite was undertaken with the idea of establishing three ranges in metal value for each of the elements of interest:

<u>Background</u> = the normal abundance of an element in barren material

<u>Threshold</u> = a range in values, greater than background, less than anomaly

<u>Anomaly</u> = a high range in values, possibly indicative of ore

General description of the area

Little is known of the mineralogy or tenor of the ore, as the mine has been inaccessible. Accurate mineralogic descriptions were not published during the main period of activity in the 1920's under Getchell management. Perhaps the most succint description is that of Vanderburg (1939, p. 64): "........Past mining operations have been confined to the Betty O'Neal and Estella veins, which strike nearly north and south, dip an average of 45° westward, and range from a few feet up to 55 feet in width. The ore bodies are of the replacement type in limestone and slate, cut by porphyry dikes. In places the limestone is highly silicified. The ore containing chiefly silver with a little copper and lead, is a mixture of silicified limestone and slate, fractured and recemented by calcite and quartz. The sulphide ore minerals are tetrahedreite, stephanite, argentite, polybasite, galena, pyrite, and sphalerite. In the oxidized ore near the surface the principal silver mineral is cerargyrite associated with copper in the form of malachite and azurite.........."

From this description, it is concluded that the following chemical elements occur in the Betty O'Neal ores: sulfur, antimony, iron, chlorine, copper, lead, zinc, and silver. By analogy to mines of this type elsewhere, arsenic, mercury, and manganese might also be suspected to be involved in the processes of ore deposition. For these reasons, antimony, arsenic, copper, mercury, manganese, silver, and total heavy metals (copper, lead, and zinc) were selected for determination in the orientation suite.

Sampling procedure

Soil samples were collected at a depth of 8 inches, and consisted of about 10 grams of material, dry weight. The samples were put in Canaco waterproof bags. They were shelf dried, and pulverized to -80 mesh in teflon lined semi-micro pulverizer with ceramic plates.

In the Betty O'Neal Mine area, as is often the case elsewhere in the Great Basin, there is considerable variation in thickness of soil cover. The question commonly arises whether comparisons can be directly made between samples collected from only four or five inches of soil material resting directly upon bedrock, and those taken at 8 inches depth from a soil known to be several feet thick. Experience indicates that no difficulty is encountered in making such comparisons. In Nevada, at least in the mountainous regions where mineral exploration work is carried out, imperfect soil is developed. Sporadic, low rainfall, and harsh weather do not favor the development or preservation of well developed soil profiles. Most soils can properly be called "lithosols" rudely comparable to the "C" zone, or material that consists of partially broken down parent rock material which normally occurs at the base of the soil profile in more fertile regions. Whether a lithosol is half a foot thick or three or four feet thick seems to introduce no major variance in soil sample geochemical results.

The tests performed were antimony (Sb), arsenic (As), copper, cold extraction (Cu_{cx}), manganese (Mn), mercury (Hg), silver (Ag), and total heavy metals; copper, lead, and zinc, cold extraction (THM_{cx}). The following tabulation lists the various analytical methods employed:

Antimony	Ward and Lakin (1954)
Arsenic	Almond (1953)
Cold Copper	Canney and Hakins (1958)
Manganese	Ward, Lakin, and Canney (1963)
Mercury	Lemaire detector, 0.1 l pump
Silver	Bloom (unpublished, 1965)
Total H.M.	Bloom (1955)

The recent, much publicized test for silver devised by Bloom is as yet not available to the profession in general. An adequate test recently devised by the U.S.G.S. (Hagmm and Lakin, 1965), is unproven and is much more laborious than Bloom's. Prof. Bloom has made his test available to the writer, as a means of further controlled testing prior to publication.

Geochemical results

Each of the elements is discussed separately below, and frequent reference is made to the individual maps portraying analytical results. An attempt is made to evaluate each element in terms of the significance of the geochemical results, as well as practicability of the element in future exploration as an indicator of Estella-type ores.

In referring to the geochemical maps, the reader's attention is directed to an apparent anomaly in the northwest corner of the sample grid, centering over sample nos. 18, 19, 22, and 23. This area shows positive results for practically each of the elements, and may represent an untested exploration possibility. If investigation of the surface reveals no obvious source of contamination such as old haulage road, ore storage, assay office, etc., it might be worthwhile to see where this anomaly projects through the nearest mine workings.

Antimony.--Aside from the subsidiary anomaly just mentioned, two pronounced geochemical trends are observed in the distribution of antimony values. An impressive trend is along an apparent fault or other mineralized structure trending down the small valley from sample nos. 86-96 N 20° W to sample no. 22 and sample no. 1. A rude high is positioned over the Estella vein, indicating geochemical relief to be as follows:

background = 0 - 15

threshold = 15 - 25

anomaly = + 25 ppm Sb

Unfortunately, the anomaly is large, and broad areas are in the threshold range for antimony. Mineralized faulting, not known to contain ore shoots, shows up at least as well as the vein itself. Furthermore, the analytical procedure for antimony is very tedious and exacting. More suitable techniques were found (see below) and the use of antimony in general prospecting in this area is not recommended.

Arsenic.--Unusually large amounts of arsenic in the soil show no clearly definable relationship to known ore, although it will be noted that one of the broad arsenic highs is positioned over the Estella shoot. Because of the erratic distribution of arsenic in the area, the element is not recommended for use in the district.

Copper (cold extraction).--Only a very general positive correlation can be made between Cu_{cx} values and the Estella vein. Copper is here apparently quite mobile in the soil environment, and migration of the element conforms only partially to the topography. Use of copper is therefore not recommended in geochemical exploration of the district. Although the method is simple, it would introduce difficulties in interpreting exploration targets. Other more suitable methods are indicated (see below).

Mercury.--As has been observed elsewhere by the writer in connection with precious metal mineralization, mercury over the Estella vein suboutcrop appears to exhibit a peripheral pattern to ore. In this case the hanging wall and one end of the ore shoot appear to be appreciably higher in trace mercury than the ore itself. It might also be presumed that mercury may occur over the tops of blind ore shoots, making it a valuable guide to ore at depth. This may be taken up again at a later depth, after shallow exploration possibilities have been thoroughly investigated.

For the time being mercury should not be used, even as an indirect indicator of ore, in the Betty O'Neal area.

Silver.--A positive anomaly for silver is shown over the Estella ore shoot, indicating that a stable oxidized compound of silver is retaining this element in the soil. Silver is probably fixed as the chloride. This relationship is the most significant result of this investigation. Geochemical relief is indicated to be:

background = 0 - 15

threshold = 15 - 20

anomaly = + 20 ppm Ag

Bloom's new determinative technique for silver is quite simple, and is subject to only one apparent shortcoming. Mercury, and perhaps Bismuth as well, contribute a yellowish color to the dithizonate colorimetric reading made at the end of the test. Mercury interference can be eliminated by muffling the samples before analysis, although mercury is not thought to be present in the samples containing appreciable silver (see above). In any event, it appears possible to make suitable readings in spite of the interference, although accuracy is not quite as good as might otherwise be the case.

Total heavy metals (cold extraction).--A well-defined THM_{cx} high is observed over the Estella ore shoot. The heavy metal is suspected to be lead or perhaps partly zinc. It is rarely copper. There is a tendency toward dispersion or "training" of values downhill from the subcutcrop, indicating the secondary lead or zinc oxidized compound to be slightly unstable. The range in values is indicated to be:

background = 0 - 10

threshold = 10 - 15

anomaly = + 15 ppm THM_{cx}

The cold extraction of the total heavy metals is one of the most simple of the geochemical tests. It is indeed fortunate that it may find application on the Betty O'Neal ground. Any two adjacent samples showing 10 ppm THM_{cx} may be considered to approach a threshold situation. The use of THM_{cx}

as a reconnaissance tool, followed up with silver as a detailed method, is described below under the heading "Exploration Recommendations".

Conclusions

Two of the simplest and most straightforward of the geochemical methods show greatest potential for use in geochemical exploration of the area. Total heavy metals (cold extraction) and silver show promise as indicators of Estella-type ore.

Antimony and manganese show positive results, but anomalies are large, and broad areas are in the threshold area. Furthermore, the analytical techniques for these elements are more complex than for silver and the total heavy metals. The most practical use of antimony and manganese would be if a rapid check of large areas on a wide-spaced sample grid were desirable. Such work is not recommended.

Copper (cold extraction) is not a reliable indicator of ores of the Estella type. Slight geochemical contrast is obtained, and the correlation between high values and ore is slightly confused because of the apparent supergene mobility of copper.

Arsenic shows a pattern of broad, erratic highs, not all of which are related to ore. The method is not recommended.

Mercury is notably higher in the hanging wall of the Estella vein, the actual ore shoot showing a negative correlation with mercury values. This peripheral distribution is thought to be an inferior guide to ore.

Exploration Recommendations

Results of this orientation study point to a simple geochemical exploration program of the main properties of Betty O'Neal Silver Mine, Inc. Mr. Ketron has indicated a rectangular area, elongate north-south, comprising about one square mile of prime interest. If this area were soil sampled on a 100-ft. grid, approximately 3,000 samples would be collected. Mr. Ketron already has taken about 1,000. If these samples have not been contaminated with metal (staples, clasps, storage trays, metal sample scoops, etc.), they may be useful. He believes that collecting the additional 2,000 would not be unduly difficult.

These samples should be dried, and either screened or pulverized depending upon the size fraction that contains the silver values. This will require a small amount of experimental work. The cost of screening is approximately the same as pulverizing. The question is, which method will yield superior results.

All of the 3,000 samples should be run for THM_{cx}. Any two adjacent samples that run greater than 10 ppm THM_{cx} (or the sixth that show the highest THM_{cx} values) should be run for silver. Any sample that shows more than 15 ppm silver constitutes a reconnaissance anomaly.

The area of the reconnaissance anomaly sample should be sampled in detail in the following manner. Detailed samples should be collected on 10-ft. centers on a square 40 x 40 ft. centered over the anomalous reconnaissance sample. Twenty-five detailed samples would thus be collected at each anomalous reconnaissance sample site. Each detailed sample should consist of 5 separate sample pits, when viewed in plan, resembling the 5-spot of gambler's dice. Two or three grams of material is collected from a pit at the anomalous reconnaissance sample, and two or three grams are collected from each of four pits in the quadrants of the compass. The five portions are mixed together in one 10 to 15 gram sample.

The reason for the extra precaution in silver samples is the expected small size of silver anomalies, as well as elusive behavior of the element during oxidation and weathering.

If a large number of silver anomalies results from this geochemical follow-up work, it might be necessary to restrict initial attention to the best half dozen or so for actual exploration and development. Only at this point would it be necessary to utilize geologic criteria in selecting or interpreting prospects. Even at this point, the writer would prefer to select from the geochemical prospects on the basis of ease of exploration and development, rather than suspected geologic favorability. It is at precisely this point that most exploration ventures go astray. The drilling of oxidized precious metal occurrences is notoriously discouraging. If a short tunnel or shallow shaft and crosscut can be planned at anything approaching the cost of drilling, an underground opening is by far the superior exploration method. In this regard, the obvious point might be re-emphasized. A well-defined silver anomaly in soil reflects an extremely shallow target that can be expected to be deeply weathered. Drill hole interpretation is very difficult under these conditions. On the other hand, short tunnels can often be easily driven, especially by mounting a scraper at the portal to eliminate mucking and tramming. Up to 50 feet or so, the resulting small size and increased efficiency lowers costs to the point where tunneling may be seriously considered as an exploration technique. It has been the recent experience of the writer that the biggest difficulty is a peculiar feeling on the part of management that no physical work should be done underground until the prospect has been proven up by some other means.

References

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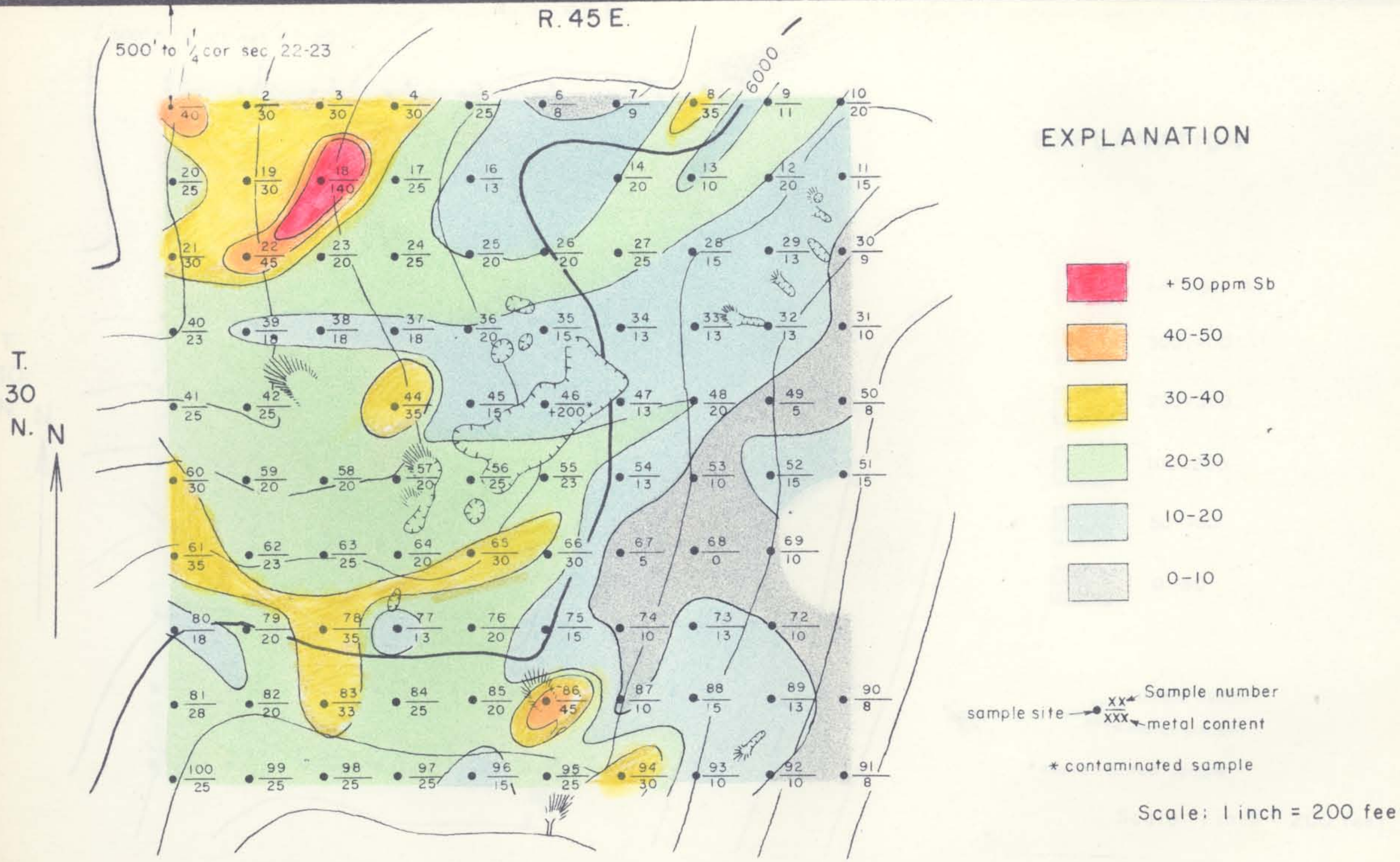
Anthony L. Payne

Anthony L. Payne, Mining Geologist

Reno, Nevada
April 25, 1965



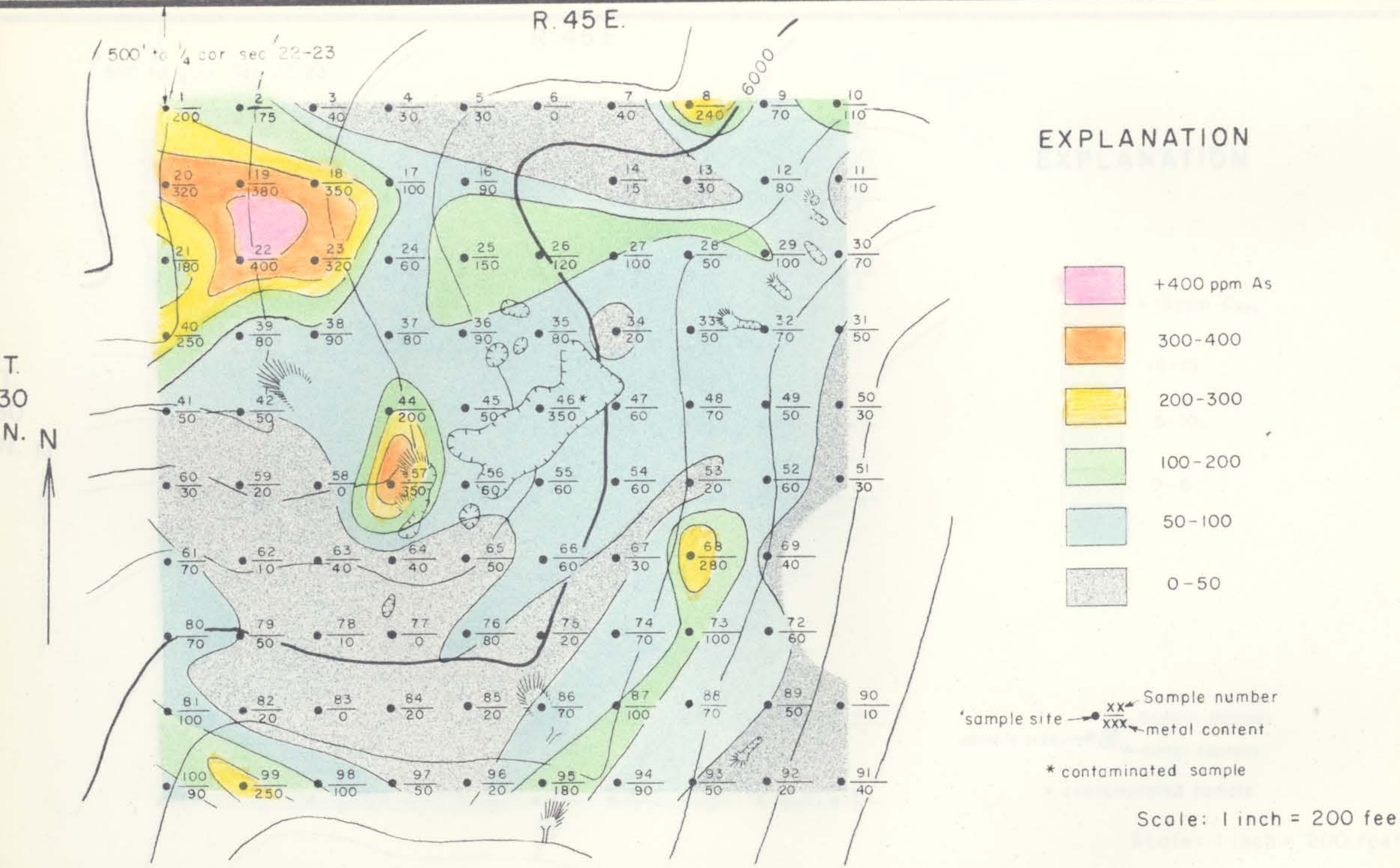
Lander County *Nevada*

GEOCHEMICAL MAP

ANTIMONY

BETTY O'NEAL SILVER MINE PROPERTY

Sampled by Douglas Ketron, April, 1965 Geochemistry by Anthony L. Payne, April, 1965

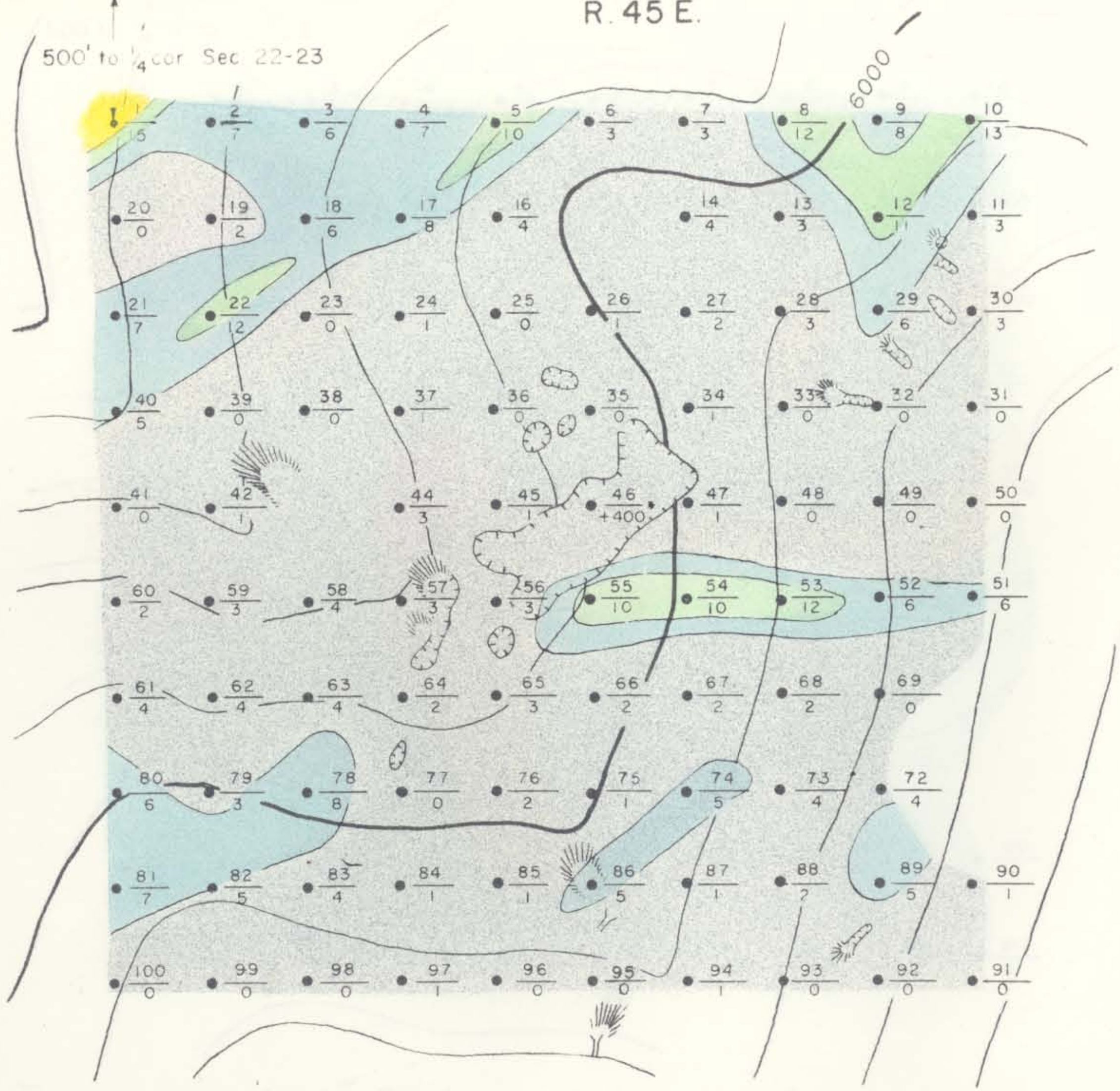


GEOCHEMICAL MAP

ARSENIC

BETTY O'NEAL SILVER MINE PROPERTY

Sampled by Douglas Ketron, April, 1965 Geochemistry by Anthony L. Payne, April, 1965



EXPLANATION

+15 ppm Cu_{cx}

10-15

5-10

0-5

sample site → • XX ← Sample number
XXX ← metal content

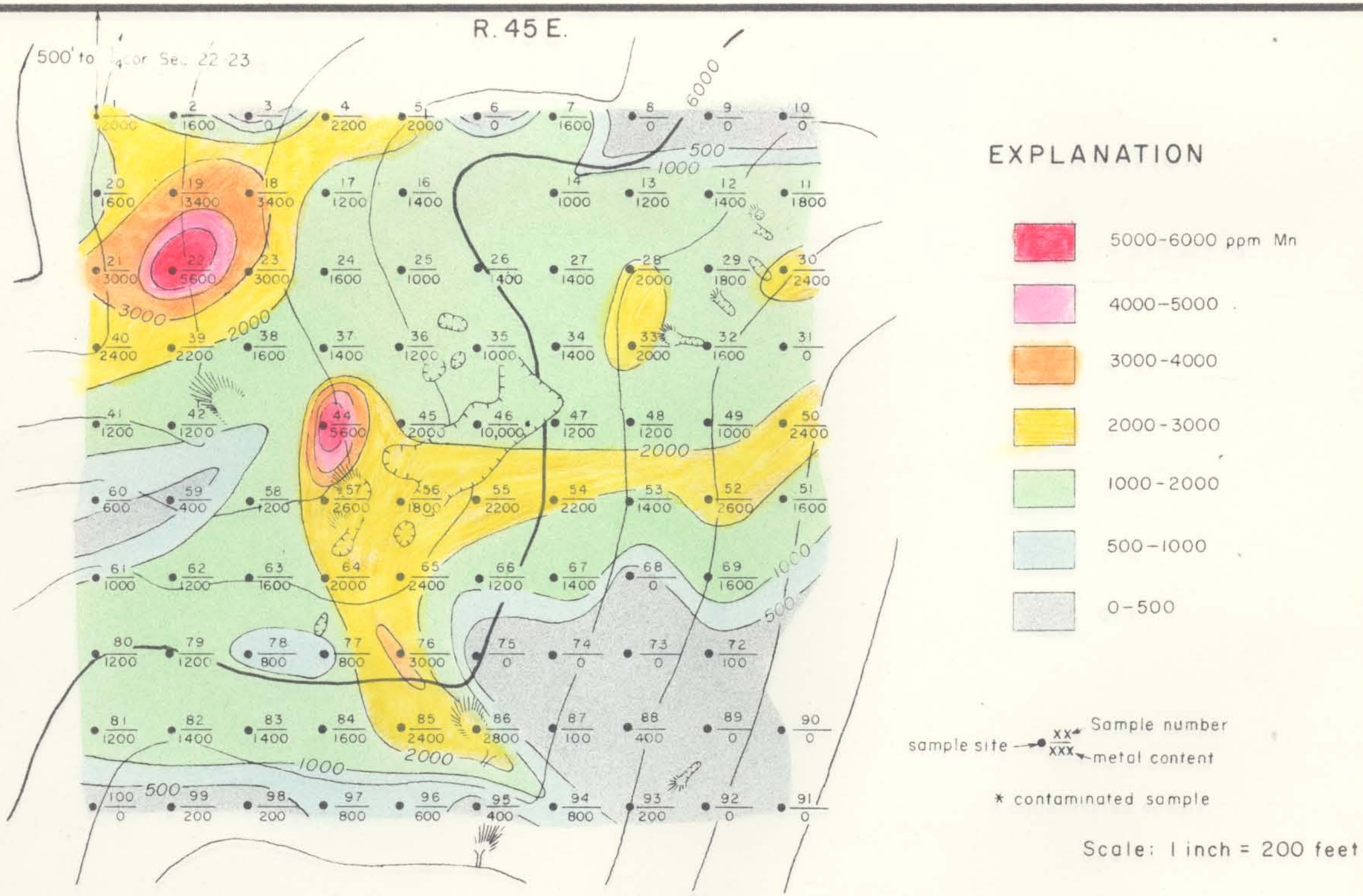
* contaminated sample

Scale: 1 inch = 200 feet

Lander County *Nevada*

GEOCHEMICAL MAP
COLD COPPER
BETTY O'NEAL SILVER MINE PROPERTY

Sampled by Douglas Ketron, April, 1965 Geochemistry by Anthony L. Payne, April, 1965



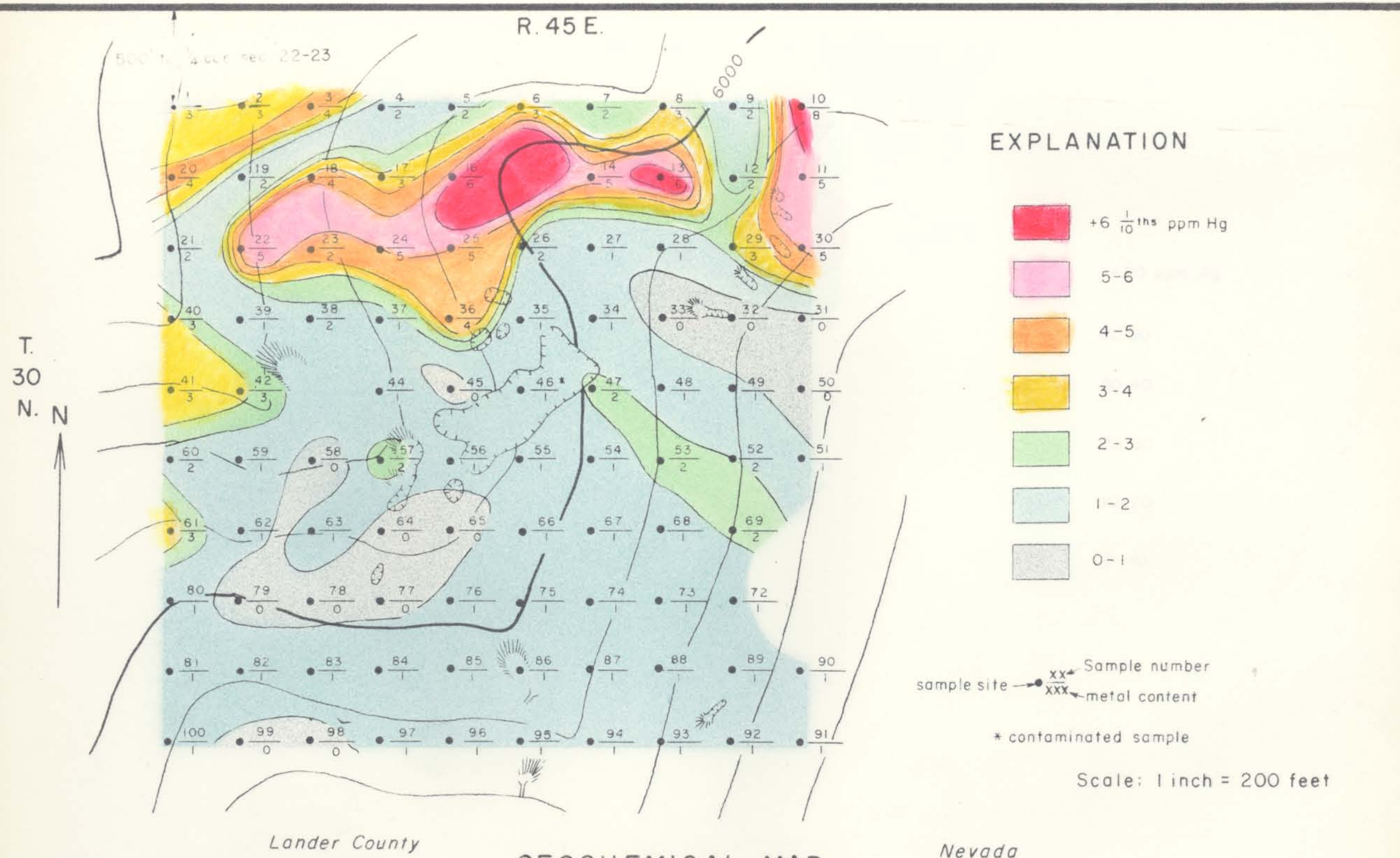
Lander County *Nevada*

GEOCHEMICAL MAP

MANGANESE

BETTY O'NEAL SILVER MINE PROPERTY

Sampled by Douglas Ketron, April, 1965 Geochemistry by Anthony L. Payne, April, 1965

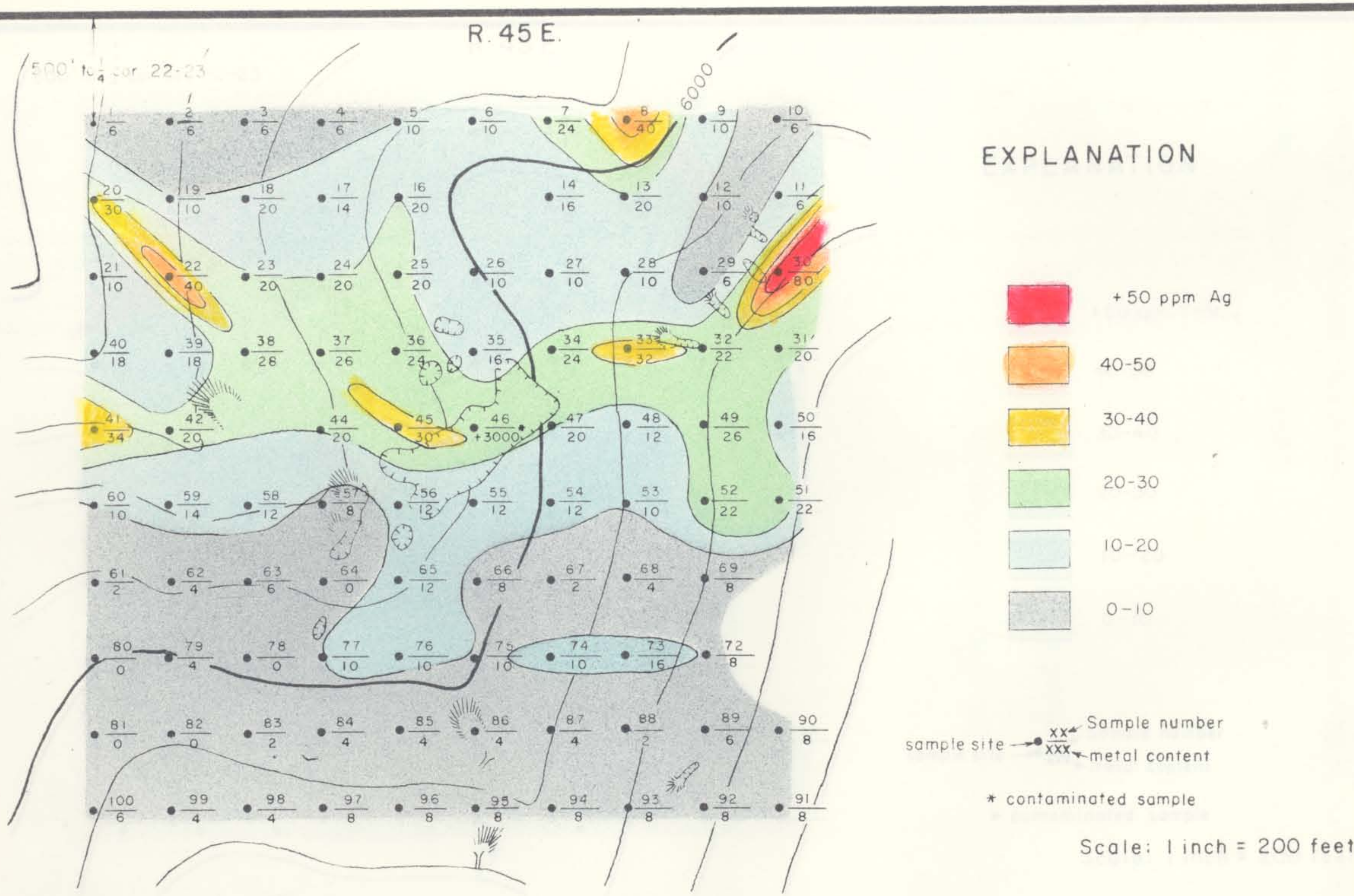


GEOCHEMICAL MAP

MERCURY

BETTY O'NEAL SILVER MINE PROPERTY

Sampled by Douglas Ketron, April, 1965 — Geochemistry by Anthony L. Payne, April, 1965



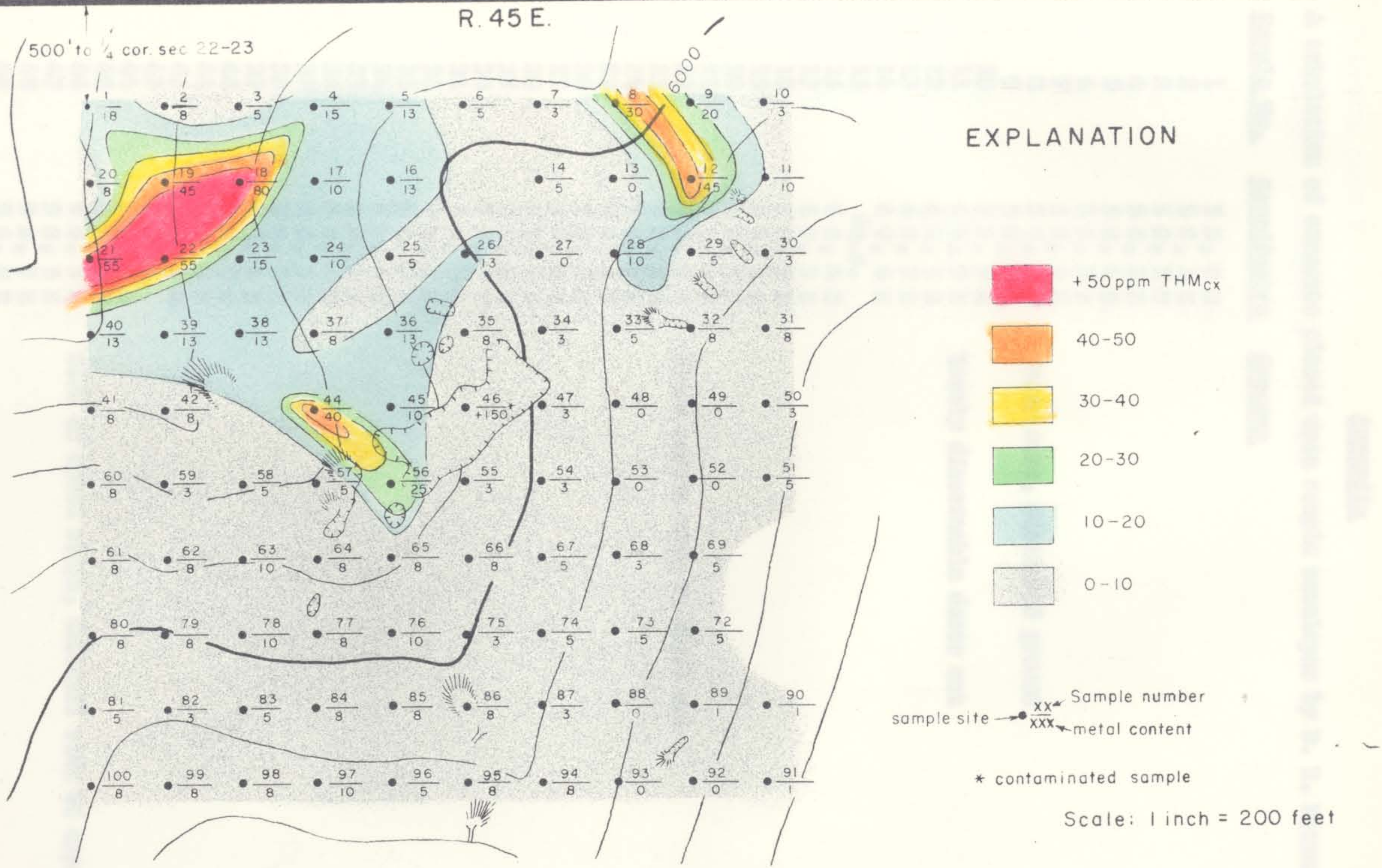
Lander County *Nevada*

GEOCHEMICAL MAP

SILVER

BETTY O'NEAL SILVER MINE PROPERTY

Sampled by Douglas Ketron, April, 1965   Geochemistry by Anthony L. Payne, April, 1965



Lander County

Nevada

GEOCHEMICAL MAP

TOTAL HEAVY METALS

BETTY O'NEAL SILVER MINE PROPERTY

Sampled by Douglas Ketron, April, 1965 Geochemistry by Anthony L. Payne, April, 1965

Appendix

A tabulation of comments placed upon sample envelopes by D. R. Ketron, sampler.

Sample No.	Coordinates	Comment
1	5 S, 0 E	
2	5 S, 1 E	
3	5 S, 2 E	
4	5 S, 3 E	
5	5 S, 4 E	
6	5 S, 5 E	
7	5 S, 6 E	
8	5 S, 7 E	Dozer cuts, disturbed ground
9	5 S, 8 E	
10	5 S, 9 E	
11	6 S, 9 E	Barely discernable dozer cut
12	6 S, 8 E	
13	6 S, 7 E	
14	6 S, 6 E	
15	*n.s.	
16	6 S, 4 E	
17	6 S, 3 E	
18	6 S, 2 E	
19	6 S, 1 E	
20	6 S, 0 E	
21	7 S, 0 E	
22	7 S, 1 E	Above quartz vein in small cut
23	7 S, 2 E	
24	7 S, 3 E	
25	7 S, 4 E	
26	7 S, 5 E	
27	7 S, 6 E	
28	7 S, 7 E	
29	7 S, 8 E	
30	7 S, 9 E	
31	8 S, 9 E	
32	8 S, 8 E	
33	8 S, 7 E	
34	8 S, 6 E	
35	8 S, 5 E	
36	8 S, 4 E	
37	8 S, 3 E	
38	8 S, 2 E	
39	8 S, 1 E	
40	8 S, 0 E	
41	9 S, 0 E	
42	9 S, 1 E	
43	n.s.	
44	9 S, 3 E	
45	9 S, 4 E	
46	9 S, 5 E	Side of caved stope, footwall side of exposed fault
47	9 S, 6 E	
48	9 S, 7 E	
49	9 S, 8 E	
50	9 S, 9 E	

*Note: n.s. = not sampled.

Appendix (cont.)

Sample No.	Coordinates	Comment
51	10 S, 9 E	
52	10 S, 8 E	
53	10 S, 7 E	
54	10 S, 6 E	
55	10 S, 5 E	
56	10 S, 4 E	
57	10 S, 3 E	
58	10 S, 2 E	
59	10 S, 1 E	
60	10 S, 0 E	
61	11 S, 0 E	
62	11 S, 1 E	
63	11 S, 2 E	
64	11 S, 3 E	
65	11 S, 4 E	
66	11 S, 5 E	
67	11 S, 6 E	
68	11 S, 7 E	
69	11 S, 8 E	
70	n.s.	
71	n.s.	
72	12 S, 8 E	
73	12 S, 7 E	
74	12 S, 6 E	
75	12 S, 5 E	
76	12 S, 4 E	
77	12 S, 3 E	
78	12 S, 2 E	
79	12 S, 1 E	
80	12 S, 0 E	
81	13 S, 0 E	
82	13 S, 1 E	
83	13 S, 2 E	
84	13 S, 3 E	
85	13 S, 4 E	
86	13 S, 5 E	Near diggings, near vein outcrops
87	13 S, 6 E	
88	13 S, 7 E	Below dump
89	13 S, 8 E	Above side of old diggings
90	13 S, 9 E	
91	14 S, 9 E	
92	14 S, 8 E	
93	14 S, 7 E	
94	14 S, 6 E	Below dump
95	14 S, 5 E	Close to old diggings
96	14 S, 4 E	
97	14 S, 3 E	
98	14 S, 2 E	
99	14 S, 1 E	
100	14 S, 0 E	