STATE OF ALASKA

William A. Egan - Governor

DEPARTMENT OF NATURAL RESOURCES

Phil R. Holdsworth - Commissioner

DIVISION OF MINES AND MINERALS

James A. Williams - Director

GEOLOGIC REPORT NO. 24

Preliminary Geology and Geochemistry of the Sinuk River Area, Seward Peninsula, Alaska

By

Gordon Herreid

Juneau, Alaska

May, 1966

TABLE OF CONTENTS

TABLES

ILLUSTRATIONS

PRELIMINARY GEOLOGY AND GEOCHEMISTRY OF THE SINUK RIVER AREA, SEWARD PENINSULA, ALASKA

By

Gordon Herreid

SUMMARY

The geology and the soil and stream sediment geochemistry of the Sinuk River gossan area were mapped. The map area is underlain by marble and schist. Two deposits located along a schist-marble contact contain well-exposed disseminated galena-zinc-fluorite mineralization associated with silicified schist. Strong soil anomalies indicating concentrations of zinc and lead of possible economic significance were found in covered areas adjacent to these deposits.

The other deposits are limited to exposures of gossan rubble (goethite) in areas underlain by marble and are probably localized along faults. With the exception of the Monarch prospect, rubble from these deposits contains only background amounts of copper, lead, zinc, and molybdenum. The Monarch gossan contains anomalous amounts of zinc and lead and represents an interesting exploration target.

These deposits have similarities to the Illinois-Kentucky fluorspar district which could be an aid in understanding their geology.

INTRODUCTION

The Sinuk River gossan deposits lie 19 airline miles northwest of Nome along the Nome-Teller highway. These surface deposits have been examined in the past as potential iron producers (Eakin, 1915; Shallit, 1942) but found too low in grade and too small in size to be economic. The nature of the mineral deposits underlying the gossans has not been determined. The present investigation is aimed at this problem. The period from June 15 to July 8, 1965, was spent in the area and additional investigations are planned for the 1966 field season. The author was assisted by Kent Smith, who collected most of the geochemical samples.

This progress report gives briefly the geologic and geochemical results of the first season's work. One of the more interesting aspects was the discovery along the Nome-Teller highway of an area measuring approximately 2,000 feet by 6,000 feet in which the soils contain strongly anomalous amounts of zinc and lead.

GEOLOGY

The map area (figure 1) is underlain mainly by marble and schist which are correlative with the lower to middle Paleozoic marble and schist in the adjacent Nome C-1 and D-1 quadrangles (Hummel, 1962). The marble forms rubble-covered hills surrounded by lower tundra-covered areas underlain by schist, marble, and glacial deposits. Some of the streams are choked with glacial granite boulders up to 10 feet in diameter. A belt of greenstone is present in the northern part of the map area. Tertiary conglomerate is present locally along Washington Creek.

The consistent southeast plunge of fold axes throughout the area indicates that only a single system of major folds is present. The predominance of moderate dips along with some vertical beds is suggestive that the marble is in the form of large recumbent folds in a matrix of deformed schist. It is hoped that more extensive mapping of bedrock on the tundra-covered lower slopes will furnish a clearer understanding of the major structure.

Southeast trends also predominate in the outcrop patterns of the marble in the greenstone belt, and in the distribution of the mineral deposits. The gossan deposits are arranged like beads on a string in three northwest trending belts: (1) Monarch-Cub Bear-Cleveland Creek (sample 133, figure 1) gossans, (2) Two Iron Creek gossans (samples 99 and 100, figure 1), and (3) Tub Mountain-Mogul gossans. The Galena-Quarry geochemical anomalies also parallel this trend, but are obviously controlled by the schist-marble contact. The structural control of the gossans is less clear. There is evidence that at least some of these deposits are associated with faulting.

The greenstone is gradational through chloritic schist zones with the schist and is somewhat foliated. It probably was originally in a basalt flow, but could represent a pre-metamorphic sill or dike.

ORE DEPOSITS

The geology of the Monarch, Cub Bear, Galena, and Quarry prospects is shown on figures 2 and 3, and descriptions of the deposits are given below. Gossan areas at Tub Mountain, Iron Creek, Mogul, Cleveland Creek, and elsewhere were examined but not mapped in detail. Geochemical analyses of surficial gossan material from some of these are given in table 5.

The deposits fall into two groups. The first group includes the Galena and Quarry deposits, which occur at a marble-schist contact, have bedrock exposures, and little gossan. The second group is the Monarch and other gossan deposits in which mainly ferruginous rubble is exposed.

The Quarry Deposit

A fluorite-galena-sphalerite(?) deposit is well exposed near the marble-schist contact in a road metal quarry on the Washington Creek-Cripple Creek divide. Mulligan (1965) gives analyses of samples from this area, including two with "abundant" fluorite. A shallow shaft and crosscut, now unroofed, are present in the quarry. Silicified schist, which lies between the marble and normal schist, contains irregular pods and disseminations of fluorite and minor local disseminated galena. The area was mapped at a scale of 1 inch=50 feet. Several grab samples representative of the different rock types were collected (Table 1).

No mineralized areas are present in the marble-rubble slopes of the hill to the north-northwest. A strong geochemical soil anomaly for zinc and lead over an area about 2000 x 6000 feet is present in the schist that surrounds the marble (figure 1). The three geochemical samples shown on figure 3 are also strongly anomalous in zinc and lead. These samples indicate that low-grade deposits such as are exposed in the quarry can produce strong soil anomalies. A distinct possibility remains, however, that ore grade material underlies parts of the large soil anomaly.

The silicified schist has a banded texture with irregular layers, rods, and fold hinges of white quartz, mostly narrower than 1/4 inch, separated by quartz mica schist layers which are locally limonitized. Limonite is most abundant along the marble contacts and around the fluorite masses. Locally in these areas, low-grade disseminated galena occurs in quartz veinlets. Silicification is restricted to the schist within a few feet of the marble contact and is a replacement of layers in the schist. There has been no silicification of the marble. Irregular white patches of marble in the normally light gray marble are apparently due to alteration. Irregular masses of dolomite and dolomite breccia (dolomite fragments up to an inch in diameter in a calcite and quartz matrix) furnish a link with the Monarch and Cub Bear occurrences, which also have associated dolomite.

Low-grade fluorite a few feet south of sample N is associated with limonite lumps in a quartz-fluorite vein. The quartz-fluorite vein and the adjacent schist layers swirl around the lumps of limonite, which appear to have been rotated. The sulfide(?) mineral which has been replaced by limonite was either present at the time of movement or has

Table 1 - Assay and Geochemical Samples from the Quarry Deposit

Sample No.	Field No.	Type of Sample	Cu	Pb	Zn	Mo	Au	Ag	Fe	Bi	Mn	Ba
M	5C-293-6	6' grab	N.D.*	1.1%	1.1%	- -	Nil	0.40 oz/T	12%	Tr	Minor	Tr
N	5C-293-14	50' grab	N.D.	4.0%	0.34	- -	Tr	2.0	1-2%	--	--	--
O	5C-293-15	83' grab	N.D.	0.63	0.30	- -	Tr	Tr	--	Tr	Minor	--
P	5C-293-18	2" grab	N.D.	25.	0.12	- -	0.02	5.30	--	--	--	--
Q	(L-200)	geochem soil	50 (ppm)**	1180 (ppm)	+1000 (ppm)	2 (ppm)	--	--	--	--	---	--
R	(L-201)	geochem soil	85 (ppm)	+1000 (ppm)	+1000 (ppm)	2 (ppm)	--	--	--	--	--	--
S	(L-202)	geochem soil	30 (ppm)	+1000 (ppm)	+1000 (ppm)	2 (ppm)	--	--	--	--	--	--

* N.D. - Sought, but not detected

** Parts per million

M - Dark brown surface rubble, some light brown quartz, banded gray schist with moderate limonite stain. Representative of dark brown material at marble-silicified schist contacts. A 6-inch fluorite zone was excluded from the sample.

N - Limonite-quartz rock makes up 20-30% of sample, remainder is banded silicified schist.

O - Brown banded silicified schist without limonite lumps, such as are present in N.

P - Sulfide with yellow-green oxidation stain, 1-2 inches wide along a quartz vein in dolomite, parallel to dolomite-schist contact.

See figure 3 for location of samples.

replaced an earlier synkinematic mineral. Several pieces of float with these limonite-filled augen structures were seen in the area, and some are closely associated with quartz-galena veinlets in the vicinity. These augen appear to have formed during the regional deformation and metamorphism of the country rock. It seems likely that the associated ore minerals are later, but there is no field evidence of this. Another instance of ore associated with structures formed during regional deformation is the complex minor folding of the dolomite at the Cub Bear prospect.

Monarch Prospect

At the Monarch prospect, a gossan area of about 85 acres contains float consisting of gray marble, ferruginous marble, and 1 to 50 percent limonite (figure 2). This gossan forms two elongate north-trending zones which underlie saddles that cross a prominent ridge near the head of Washington Creek. Exposures are mainly rubble except in a few of the many old trenches in the area.

In the more intensely mineralized sections where more than 5% of the surface rubble is dense, noncalcareous limonite (goethite), the only other constituent is ferruginous marble, highly effervescent with Hcl. Assays of the material are given in tables 2 and 3.

Table 2

Analysis of composite sample of iron ore from Monarch group of claims1/
(Analyst, R.C. Wells, United States Geological Survey)

SiO_2	5.53	TiO_2	None
Al_2O_3	1.34	P_2O_5	.13
Fe_2O_3	78.30	S	Trace
MgO	.10	MnO	1.37
CaO	1.97	BaO	Trace
H_2O	10.40		100.24
CO_2	1.10		

1/ Eakin, 1915, p. 363

The iron, manganese, phosphorus, and sulphur contents of the ore, calculated from this analysis, are as follows: Fe, 54.80%; Mn, 1.06%; P, 0.057%; S, Trace.

Table 3
Analysis of typical "iron ore" Monarch prospect2/

Sample Number	Acid Sol. Fe	Acid Insol. Fe.	Calc. Total Fe	Cu	V	Mn	S	P	SiO_2
Sinuk 22	52.9	0.26	53.16	<0.2	<0.005	0.27	<0.004	0.001	4.12

Peripheral to these zones are areas with less than 5% dense limonite, ferruginous marble gray marble and up to 10% fine-grained dolomite. Where exposures are favorable it can be seen that ferruginous marble rims the limonite veinlets in unaltered gray marble (1 mm grain size) and dolomite occurs as fracture filling veins or irregular replacement masses in the gray marble. Peripheral to these limonite-bearing areas is a large area of barren, much fractured, light gray fine-grained dolomite. This material effervesces only slowly in acid and has also been identified by X-ray diffraction as dolomite. In some areas peripheral to the low-grade marble-limonite, the dolomite carries about 1% limonite as scattered ± 1/8" veinlets.

Between the two prongs on the north end of the eastern ore zone (locality E, figure 2), the bedrock is typical dolomite, fine-grained, buff weathering, and closely fractured so as to break up into small fragments. It contains calcite streaks and apparently represents incomplete dolomitization of marble. There is no limonite veining. Three hundred feet northeast the bedrock is unaltered medium gray marble. with 1 mm grains, similar to the marble of the region. This rock is cut by veins and irregular replacement masses of fine-grained light medium gray dolomite. There are no massive limonite veins. The occurrence in these two localities is probably typical of the less exposed areas and is an indication of a hydro-thermal origin for the dolomite.

At the south end of the saddle (locality F, figure 2), marble breccia is present in a prospect pit. Similar breccia is present along the ore-marble contact north of the saddle. This breccia and the north trending elongation of the ore and dolomite zones suggests fault control of the mineralization. Note that the two structural attitudes north and south of the saddle differ from the otherwise monoclinal dips along the ridge.

The west ore zone is 320 feet wide and is bounded on the west by unmineralized gray marble and on the east by dolomite without limonite veins. Except in some of the prospect trenches and pits, only rubble is exposed. The ore zone contains up to 30-40% limonite rubble, ferruginous marble, and some gray marble. In the trenches limonite veins can be seen to cut gray marble. Locally, goethite and white crystalline calcite with a dusting of pyrolusite form open space fillings in the marble breccia. Pyrolusite has been reported previously, but on the samples collected by the author it was very minor. The manganese content of the breccia is about 10% (determined by X-ray fluorescence) and is apparently due largely to manganese in goethite and possibly manganosite(?). The west ore zone contains a north trending line of dolomite breccia rubble patches about 70 feet west of the contact with the dolomite. These patches are a few feet in diameter and are similar in appearance to frost boils.

The highest grade gossan material is in the east ore zone. The strongest geochemical anomalies for zinc and lead were found in this area also. The surface rubble is composed of ferruginous marble and up to an estimated 50% limonite. No rock in place was seen in these high-grade zones.

Cub Bear Prospect

The Cub Bear prospect lies just west of a tundra-covered saddle in the divide between Ashland Creek and Cripple River. Ore exposures in the flat area on the divide and on the steep hill slopes at the south end consist of rubble only, but give a clear indication of the distribution of rock types. Along the sides of the deposit bedrock is exposed in several places.

The deposit is a ferruginous zone 4,400 feet long and 100 to 260 feet wide (figure 2). The surface rubble overlying the deposit consists of dark yellowish-orange, cellular, ferruginous marble, light gray dolomite without limonite stain, and slightly calcareous dark purplish brown goethite (limonite) in places pseudo-morphous after cubic pyrite. In the richest sections, limonite is estimated to make up 40% of the surface material. An assay of a representative grab sample of the surface material at D (field sample number 5-C-285) in one of the richer areas showed 16% iron. Copper, lead, and zinc were less than 0.05%. The deposit is too small and too low in grade to be an economic source of iron ore. Geochemical samples were taken across the zone (samples 94, 95, 96, 97) and in dry creek beds below the deposit at 92 and 93. The only anomaly detected was for lead (95 ppm) in sample 94, taken in apparently unmineralized marble about 100 feet west of the deposit.

Dolomite breccia is present in the ferruginous zone and as a discontinous barren envelope around it. In places, grayish weathering dolomite contains 5-10% angular patches of light gray weathering fine-grained marble, which appears to be a crackled marble almost completely replaced by dolomite. Elsewhere the dolomite is light gray weathering and contains no marble patches. This relationship of dolomite to ore is similar to that at the Monarch deposit.

On the west side of the south end of the deposit, unbrecciated dolomite is present with minor folds and crenulations which plunge gently south. This dolomite was evidently present at the time of folding. Either the ore and its dolomite shell were emplaced before the folding of the rocks was completed, or the ore is later than folding and has been localized along a dolomite zone with solution and redeposition of hydrothermal dolomite at the time of ore formation.

The major structure around the deposit and the structural control of the deposit are not clear. The zone lines up with the Monarch and the Cleveland Creek gossans, and the three may be restricted "ore" shoots along a fault zone. However, no fault is evident on the rubble covered hill between the Monarch and the Cub Bear deposits. The consistent gentle S to SE plunge of minor fold axes and crenulations throughout the Cub Bear area suggests that regional structures prevail.

Galena Prospect

Evidence of work at the Galena prospect consists of a ruined cabin and a number of hand-dug pits scattered over a distance of about 3,800 feet. The pits were examined and a number of geochemical soil samples taken, mainly in the covered area underlain by schist. In the area of the pits, marble is exposed in many places and the rubble is nearly in place.

The exposed mineral deposits consist of zinc and lead minerals in silicified and/or quartz veined zones in marble. Limonite (goethite) is usually present as lumps (less than 1 inch across) in the quartz and as stained zones in the marble wall rock. In trenches K and L botryoidal goethite is present. Colliform banded quartz is present in the pits at G. Ore minerals were seen in trenches at J (galena), I (hemimorphite), and K (sphalerite(?).

Table 4

Analyses of samples from the Galena prospect

Trench or pit	Width	Cu	Zn	Pb	Au	Ag	Remarks
G		<.05%	0.8%	<.05%	--	--	Pit (5C-394)
J-1	10'	<.05%	0.15%	.05%	Nil	0.35	Trench (5C-403-1)
J-2	4'	<.05%	2.9%	1.0%	.02	0.85	Trench (5C-403-2)
K	15'?	---	5.8%	- -	- -	- -	Pit (5C-402)

G - Quartz zone with colliform banding and 3/4-inch diameter limonite lumps exposed in three pits.

J - This trench is 30 feet long and crosses the marble-schist contact. From south to north, bedrock is (1) brecciated tan marble with calcite vein filling (J-1 above), (2) tan weathering fine-grained dolomite with white vein quartz filling and fine disseminated sulfide(?) (J-2 above), (3) light tan silicified schist, and (4) quartz-mica schist with biotite spots.

K - Vein quartz - silicified zone in marble, N10W trend, 225 feet long, up to 20 feet wide. Assay is of material at the edge of the pit near the north end of the zone. Four prospect pits are present along the zone, which consists of rubble exposures only. Limonite (goethite) lumps make up about 5% of the richest dump. Tan dolomitic(?) marble is present, also green chlorite associated with the limonite.

At Locality H a trench 40 feet long and 4 to 5 feet deep, exposes: (1) gray marble country rock; (2) partly silicified marble with moderate limonite stain; and (3) limonite geodes with internal stalactitic columns are indicative of shallow secondary deposition. Similar material is present in pits at L

The pits north of pit G show little or no visible mineralization.

Soil sample 38, taken 200 feet directly down the hill, southwest of the pits at G, has a moderately anomalous zinc content commensurate with the small size and low grade of the visible ore. Several soil samples from the covered schist area south of the mineralized zones in the marble show zinc values of greater than 1000 ppm and are high in lead. At least moderate amounts of zinc and lead must be present in the bedrock underlying this anomaly.

The deposits exposed at the Galena prospect furnish an example of zinc-lead mineralization along the marble-schist contact, but are not of ore grade and size themselves.

GEOCHEMISTRY

The Quarry deposit contains fluorite with zinc and lead. This same mineral assemblage, but with the addition of barite, is also present in the Illinois-Kentucky fluorspar district (Brecke, 1962; Heyl & Brock, 1961). There the deposits are in limestone along faults on a domal anticline thought to have been uplifted by intrusion of igneous rocks at depth. Limonite pipe (marcasite) deposits which occur in the same district (Brecke, 1964, p. 1295) may be analogous to the Sinuk gossans.

All geochemical sample locations are shown in figures 1, 2, or 3. The analyses are listed in table 5, and frequency distribution graphs are shown in figures 4 and 5. Threshold values are given with the graphs. Strong geochemical anomalies are present in covered areas near both the Galena and the Quarry showings. Detailed geologic maps of the associated showings are shown in figures 2 and 3. Both the Quarry anomaly and the Monarch gossan are deserving of further work.

The Monarch gossan most likely represents a pyritic deposit, perhaps similar to the limonite pipe deposits in the Illinois-Kentucky district mentioned above. Soil samples of gossan material taken at the Monarch show several moderate to high zinc anomalies and some high lead(?) anomalies. The latter values, however, may represent interference from bismuth according to the lab analyses (see table 5). These anomalies indicate that, in addition to the pyrite(?), zinc and possibly lead are present in the bedrock beneath the gossan, possibly in economic amounts.

Samples taken at the other gossan deposits, the Mogul, Cub Bear, Tub Mountain, and lower Iron Creek (sample 99) do not contain anomalous amounts of copper, lead, zinc, or molybdenum. One exception is sample 94, in the Cub Bear prospect area, which is moderately anomalous in lead.

Moderate molybdenum anomalies are present in the soil in areas north and south of Tub Mountain and in stream sediments in Washington Creek. These are probably not indicative of ore grade bedrock mineralization.

SUGGESTIONS FOR PROSPECTING

Exposures in the Quarry deposit combined with the geochemical results indicate that a large area of bedrock with more than background amounts of zinc and lead is present along the marble-schist contact that cuts across Washington Creek. Economic concentrations of ore minerals could well be present in this area. More work should be done to evaluate and possibly extend this anomaly. Further soil sampling to outline the strongest anomalies followed by bulldozer trenching should be effective in locating the areas of richest mineralization beneath the soil cover.

The Monarch gossan contains anomalous amounts of zinc and possibly lead. More detailed geochemical soil sampling should be done, followed by deep trenching or drilling in the area of strongest anomaly to explore for ore in places beneath the surface oxidation. Geophysical methods could be used to detect a buried sulfide body and give some idea of its dimensions.

REFERENCES

Brecke, E.A., 1962, Ore genesis of the Cave-in-Rock Fluorspar district, Hardin County, Illinois: Econ. Geol. v 57, p. 499-535.

Brecke, E.A., 1964, A possible source of solutions in the Illinois-Kentucky fluorspar district: Econ. Geol. v. 59, p. 1293-1387.

Eakin, H.M., 1915, Iron ore deposits near Nome: U.S. Geological Survey Bulletin 622-I, p. 361-365.

Heyl, A.V., Jr., Brock, M.R., 1961, Structural framework of the Illinois-Kentucky mining district and its relation to mineral deposits: U.S. Geological Survey Prof. Paper 424-D, p. D3-D6.

Hummel, C.H., 1962, Preliminary geologic map of the Nome C-1 quadrangle, Seward Peninsula, Alaska: U.S. Geological Survey Map MF 247, 1 p.

Hummel, C.H., 1962, Preliminary geologic map of the Nome D-1 quadrangle, Seward Peninsula, Alaska: U.S. Geological Survey Map MF 248, 1 p.

Mulligan, J.J., and Hess, H.D., 1965, Examination of the Sinuk iron deposits Seward Peninsula, Alaska: U.S. Bureau of Mines open file report. No number.

Shallit, A.B., 1942, Sinuk River iron ore deposits, Seward Peninsula, Alaska: Alaska Territorial Department of Mines unpublished report.

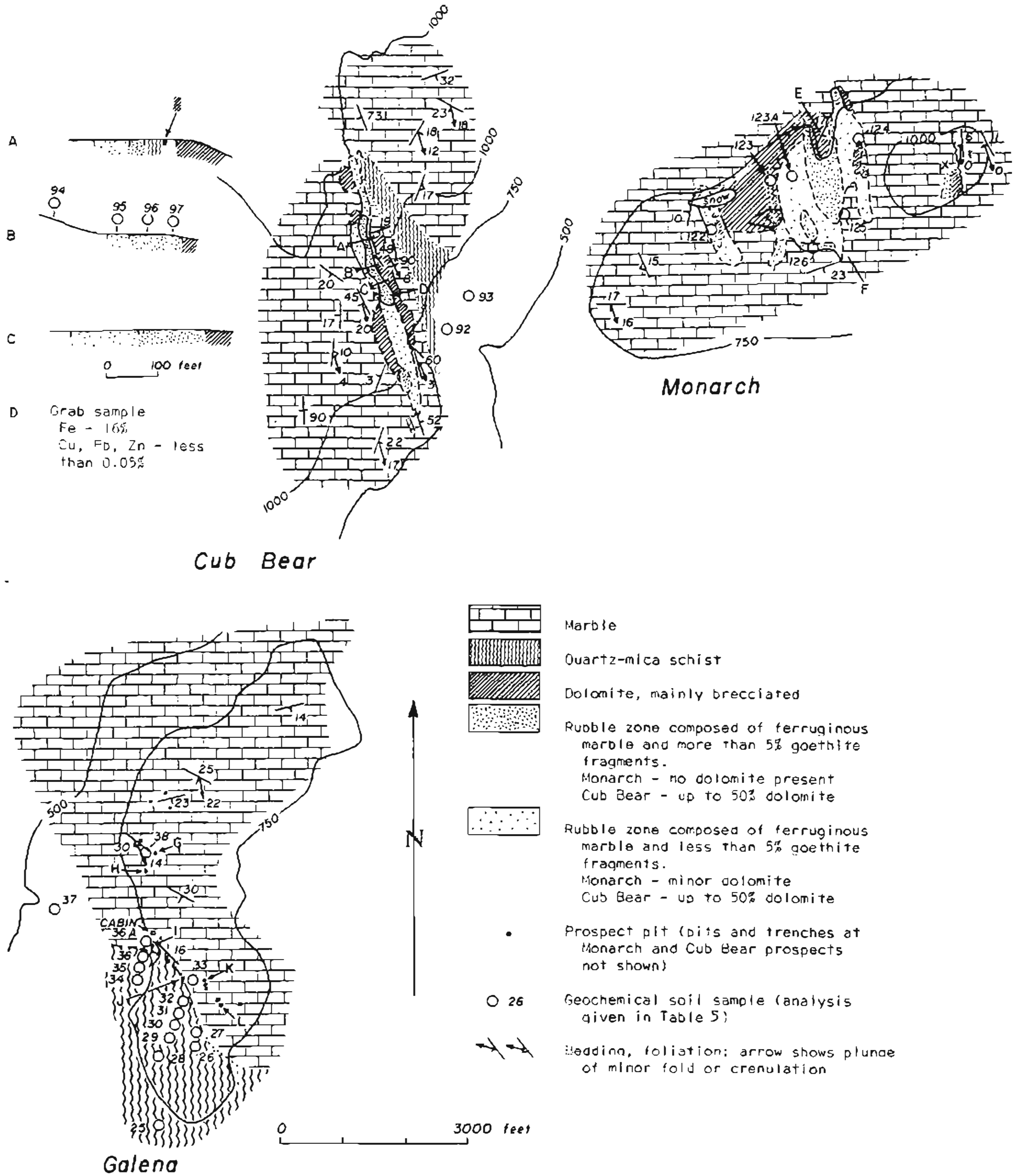


Figure 2 Geologic maps of the Monarch, Cub Bear, and Galena prospects.

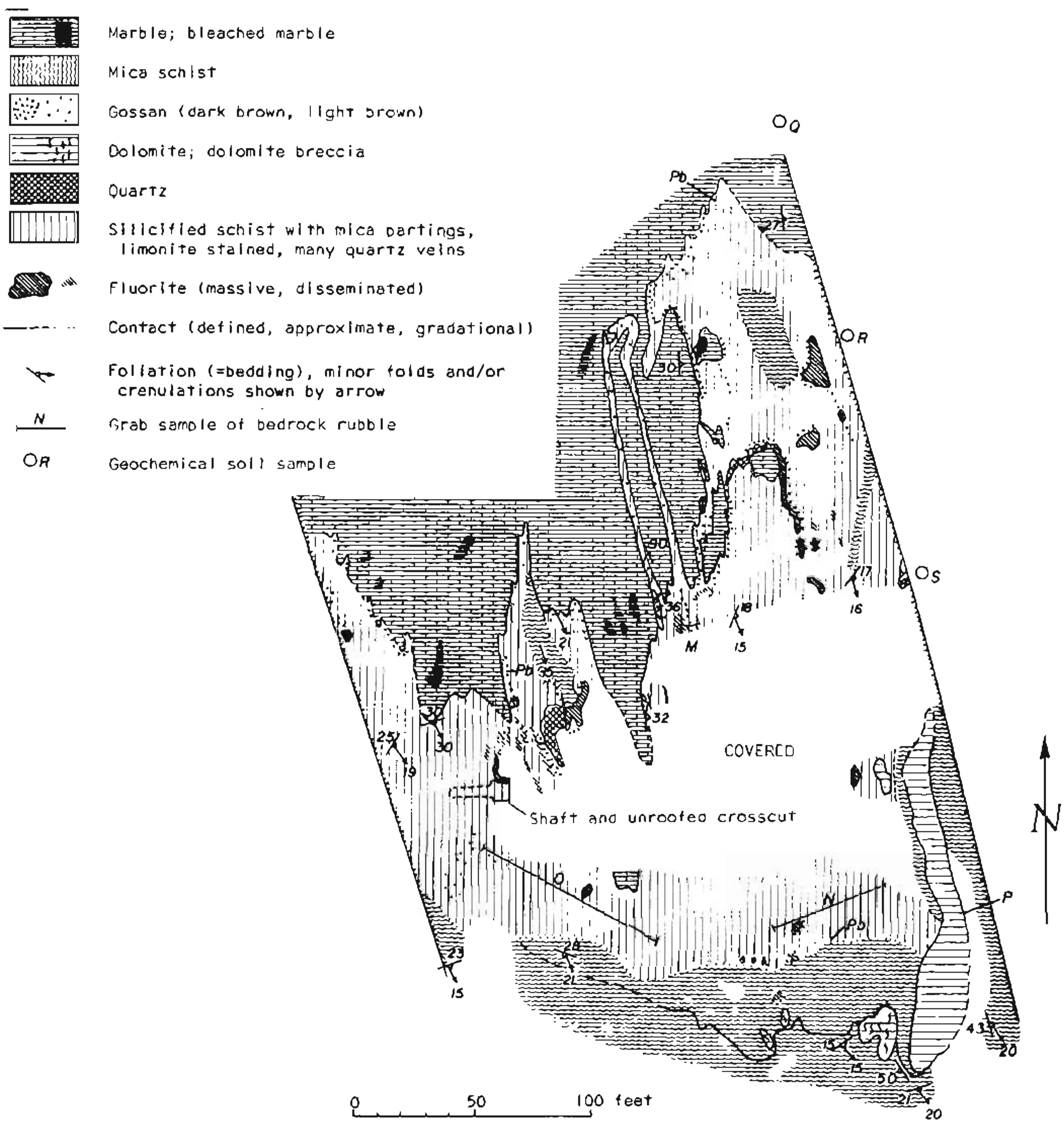


Figure 3 Geologic map of the Quarry deposit

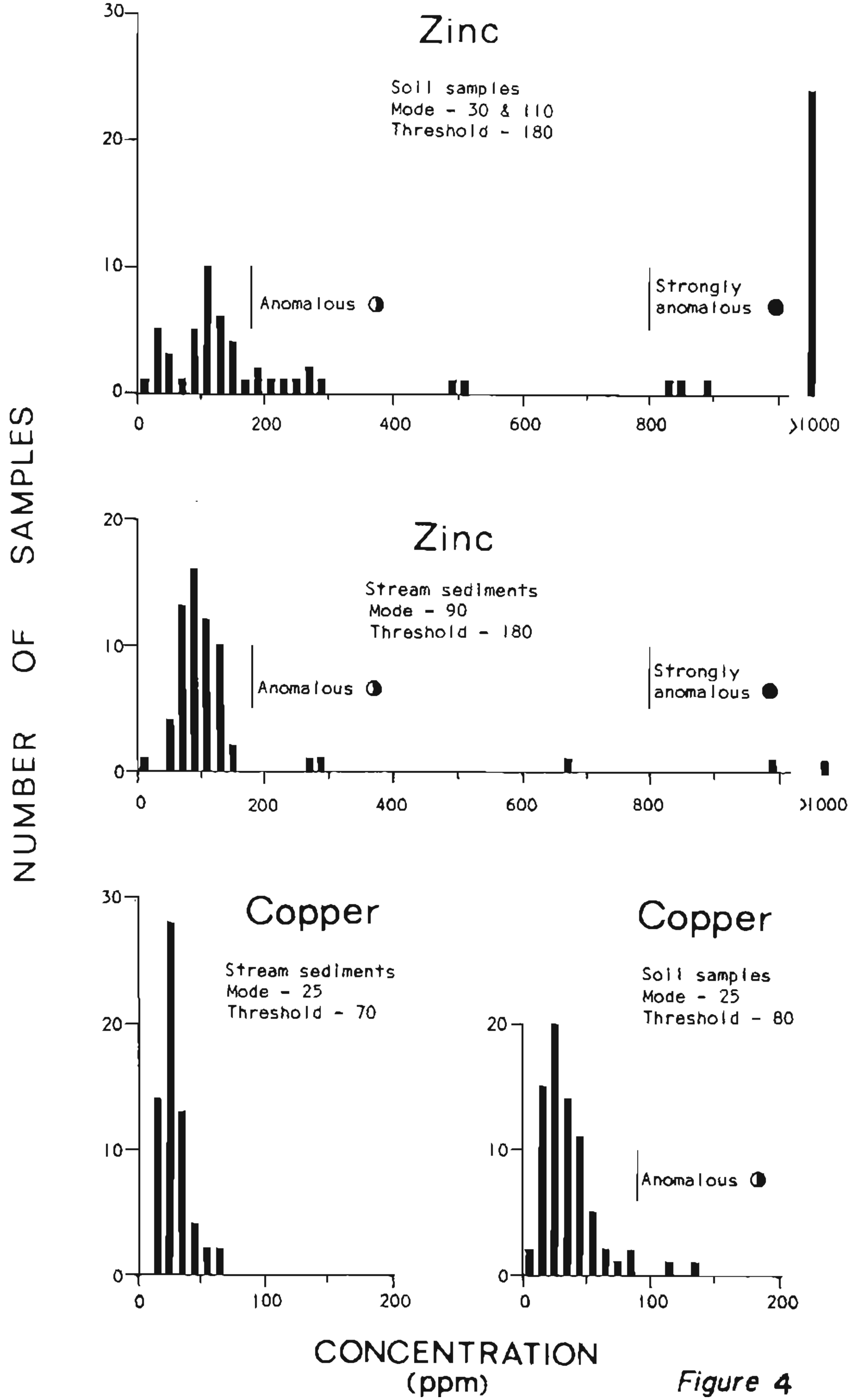
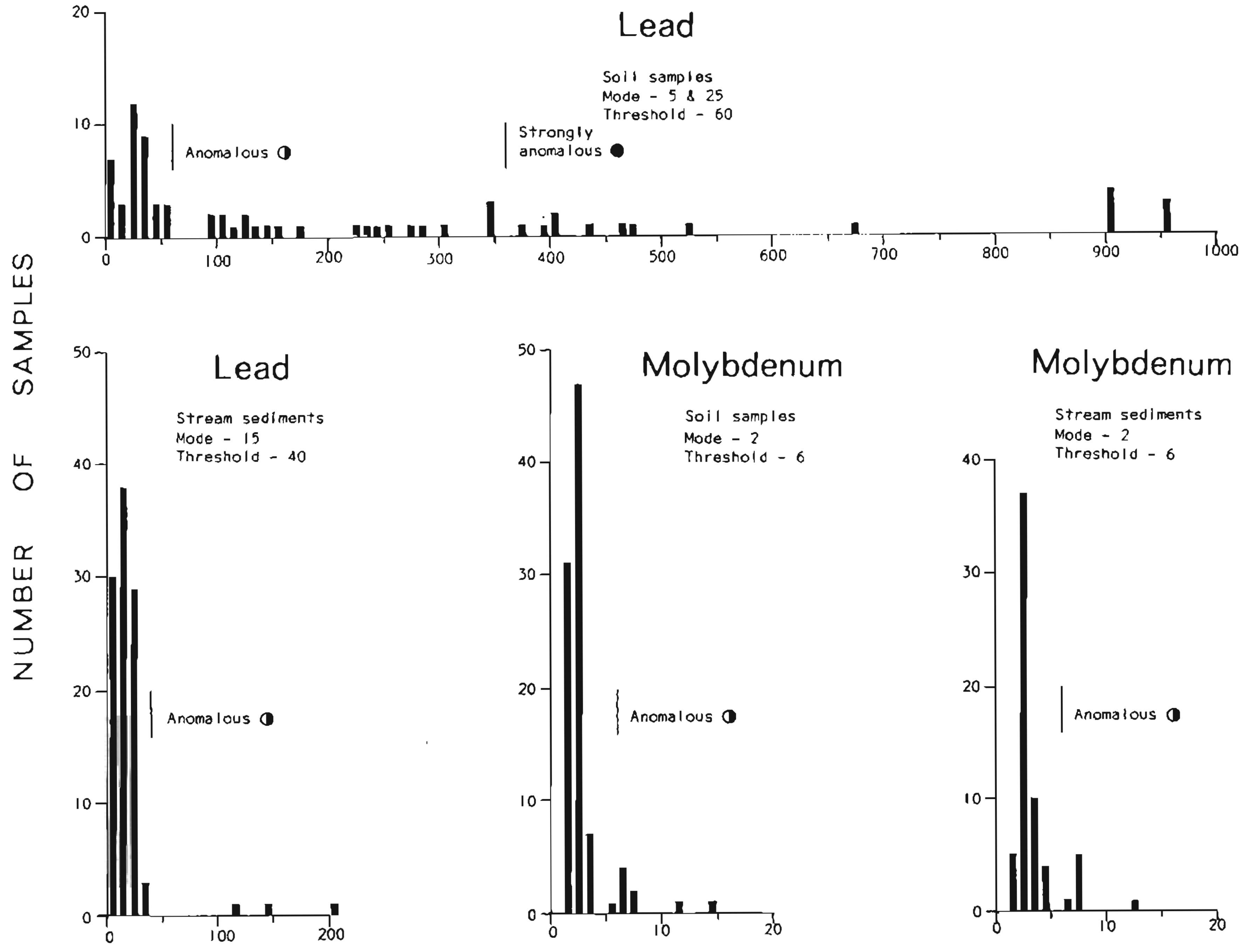

Zinc
Soil samples
Mode - 30 & 110
Threshold - 180
Anomalous
Strongly anomalous
0
10
20
30
0
200
400
600
800
>1000
Zinc
Stream sediments
Mode - 90
Threshold - 180
Anomalous
Strongly anomalous
0
10
20
0
200
400
600
800
>1000
Copper
Stream sediments
Mode - 25
Threshold - 70
0
10
20
30
0
100
200
Copper
Soil samples
Mode - 25
Threshold - 80
Anomalous
0
10
20
0
100
200
NUMBER OF SAMPLES
CONCENTRATION (ppm)

Figure 4



Lead
Soil samples
Mode - 5 & 25
Threshold - 60
Anomalous
Strongly anomalous
Lead
Stream sediments
Mode - 15
Threshold - 40
Anomalous
Molybdenum
Soil samples
Mode - 2
Threshold - 6
Anomalous
Molybdenum
Stream sediments
Mode - 2
Threshold - 6
Anomalous
NUMBER OF SAMPLES
CONCENTRATION (ppm)

Figure 5

Table 5

Laboratory and Field Analyses of Geochemical Samples (a)

Map Number	Field Number	Concentration (ppm)				Stream Sample	Soil Sediment Sample	Field Test * (b) (ml of dye)
		Cu	Zn	Pb	Mo			
1	5C-307	20	110	10	3	X		
2	5L-150	10	40	5	2	X		8
3	5L-151	20	65	10	2	X		
4	5C-295	10	15	5	2	X		5
5	5C-294	25	85	20	1	X		5
6	5C-297	20	90	10	1	X		12
7	5L-183	20	100	15	6	X		+20
8	5C-306	25	100	5	1		X	5
9	5C-298	20	90	10	2	X		5
10	5L-182	20	130	20	4	X		7
11	5C-299	20	95	10	2	X		7
12	5C-302	65	100	15	2	X		7
13	5L-184	20	115	15	2	X		18
14	5L-181	20	90	15	7	X		6
15	5L-180	25	135	25	7	X		8
16	5L-152	30	265	35	2	X		13
17	5L-153	30	105	15	3	X		5
18	5L-154	25	155	30	2	X		10
19	5L-267	50	195	35	2		X	2
20	5L-266	30	110	20	3		X	6
21	5L-265	35	35	20	2		X	5
22	5L-264	25	80	30	2		X	3
23	5L-263	40	135	25	2		X	
24	5L-262	40	65	15	3		X	7
25	5L-261	10	35	5	3		X	3
26	5L-275	20	205	95	2		X	12
27	5L-274	25	+1000	405	3		X	+20
28	5L-282	55	185	30	14		X	13
29	5L-281	65	295	55	6		X	13
30	5L-280	115	120	50	5		X	4
31	5L-271	45	+1000	150	7		X	+20
32	5L-270	30	+1000	105	2		X	+20
33	5L-269	25	850	275	2		X	11
34	5L-279	40	830	125	6		X	10
35	5L-278	45	+1000	220	6		X	+20

(a) Analyses of -80 mesh fraction by Rocky Mountain Goechemical Laboratories.
(b) Field test by Hawkes' cold extractable heavy metals method modified by using the amonium citrate extractant undiluted.

36	5L-277						X	+20
36A	5L-276	20	500	170	1		X	11
37	5L-155	35	980	140	7	X		+20
38	5C-399	25	260	45	2		X	1
39	5L-231	20	150	35	2		X	15
40	5C-319	30	110	20	2		X	3
41	5C-318	15	125	20	1	X		5
42	5C-317	25	250	30	1		X	1
43	5L-232	30	+1000	245	2		X	+20
44	5L-233	15	35	5	2		X	1
45	5L-226	15	95	125*	2		X	5
46	5L-234	20	165	100	2		X	9
47	5L-227	70	+1000	900	2		X	+20
48	5C-308	25	+1000	200	1	X		+20
49	no sample							
50	5L-230	25	230	110	2		X	7
51	5L-228	45	+1000	475	2		X	+20
52	5L-220	130	+1000	950	2		X	+20
53	5L-218	55	+1000	395	2		X	
54	5L-217	45	+1000	345	2		X	+20
55	5L-216	55	+1000	525	2		X	
56	5C-326	35	+1000	370	1		X	+20
57	5L-215	80	+1000	900	2		X	
58	5L-214	60	+1000	675	2		X	
59	5L-212	45	+1000	435	2		X	+20
60	5L-213	25	+1000	40	2		X	11
61	no sample							
62	5L-206	55	+1000	900	2		X	+20
63	5L-209	30	+1000	950	2		X	
64	5L-210	25	+1000	900	2		X	
65	5L-211	80	+1000	465	2		X	+20
66	5L-221	40	+1000	950	2		X	
67	5L-223	30	880	30	2		X	
68	5L-239	40	+1000	405	3		X	+20
69	5L-240	15	55	230*	6		X	6
70	5L-224	20	+1000	340*	3		X	
71	5L-225	20	980	130	2		X	+20
72	5L-229	30	155	30	2		X	+10
73	5L-283	25	80	15	2	X		
74	5L-284	25	145	45	2		X	
75	5L-285	35	105	20		X		

*Possible interference, Bi? (High Fe content)

76	5L-286	35	105	20	2		X	
77	5L-287	40	115	30	2		X	
78	5L-288	20	115	25	2		X	
79	5L-289	35	125	50	2		X	
80	5L-247	10	65	5	2	X		5
81	5L-246	20	90	15	2	X		3
82	5L-245	10	70	15	2	X		9
83	5L-244	10	110	20	2	X		5
84	5L-243	20	80	10	2	X		8
85	5L-242	20	85	10	2	X		2
86	5L-241	45	120	20	4	X		5
87	5L-191	25	85	10	2	X		3
88	5L-192	20	45	10	1	X		2
89	5L-193	45	105	15	2	X		2
90	5L-237	45	295	35	2	X		5
91	5L-238	25	120	15	2		X	2
92	5C-332	25	215	20	2		Dry creek	11
93	5C-334	35	95	15	2		Dry creek	11
94	5C-284-4	15	115	95	2		X	0
95	5C-284-3	10	120	35	2		X	0
96	5C-284-2	10	40	20	2		X	0
97	5C-294-1	10	55	20	2		X	3
98	5L-199	35	100	15	2	X		1
99	5C-337	10	25	-5	1		X	8
100**							X	
101	5L-194	15	65	10	2	X		2
102	5C-347	15	65	5	2	X		15
103	5L-196	20	60	10	2	X		2
104	5L-197	30	135	20	2	X		2
105	5L-198	35	140	15	2	X		4
106	5C-365	5	30	-5	1		X	10
107	5C-366	20	80	300*	2		X	5
108	5C-358	20	70	10	2	X		6
109	5L-179	20	75	5	4	X		4
110	5L-178	15	65	5	3	X		3
111	5L-177	20	105	10	7	X		5
112	5L-174	10	50	5	7	X		6
113	5L-173	15	100	250*	11		X	3
114	5L-172	15	55	5	12	X		4
115	5C-258	-5	-5	5	1		X	0

**X-ray spectrometer determination of Iron Creek gossan: 54% iron, Tr. zinc (<500 ppm), Tr. bismuth (<500 ppm)

116	5L-171	30	80	15	7		X	1
117	5L-160	20	60	10	2	X		4
118	5L-159	20	65	5	3	X		4
119	5L-158	20	90	10	3	X		2
120	5L-157	10	85	10	3	X		4
121	5L-156	15	65	5	2	X		6
122	5C-382	10	105	280*	1		X	3
123	5C-384	15	95	20	1		X	2
123-A	5C-391	10	45	140*	2		X	1
124	5C-387	35	175	25	3		X	2
125	5C-368	15	+1000	20	2		X	15
126	5C-370	25	495	340*	1		X	+20
127	5L-186	25	85	10	2	X		2
128	5L-185	30	90	10	3	X		1
129	5L-187	40	90	15	2	X		4
130	5L-188	30	105	15	2	X		2
131	5L-190	50	125	25	2	X		4
132	5L-189	50	125	15	2	X		2
133	5L-248	10	30	5	1		X	3
134	5L-249	35	120	20	2	X		2
135	no sample							
136	5L-250	35	90	15	2	X		0
137	5L-251	25	120	15	3	X		2
138	no sample							
139	5L-253-2	15	65	10	2	X		0
140	5L-253-1	30	105	15	3	X		0
141	5L-255	65	135	15	4	X		3
142	5L-256	35	675	115	2	X		3
143	5L-257	30	115	10	3	X		4

-5 Less than 5 ppm
+1000 Greater than 1000 ppm
* Possible interference, Bi(?) (High Fe content)
** X-ray spectrometer determination of Iron Creek gossan: 54% iron, Tr. zinc (<500 ppm), Tr. bismuth (<500 ppm).