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GEOCHEMICAL REPORT NO. 12

A Geochemical Investigation of Minook Creek, Rampart District Alaska

By

Willow M. Burand and Robert H. Saunders

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ILLUSTRATIONS

Note: Figures 1, 2, and 3 are adapted from U.S. Geological Survey maps of the Tanana quadrangle, 1:63, 360 series.

A GEOCHEMICAL INVESTIGATION OF MINOOK CREEK, RAMPART DISTRICT, ALASKA

By

Willow M. Burand and Robert H. Saunders

INTRODUCTION AND SUMMARY

This report presents information obtained by a geochemical investigation in the Minook Creek drainage basin, Rampart District, central Alaska. The investigation was made during July 30 to August 21, 1965, by Willow M. Burand and Robert H. Saunders.

Many mining districts in western North America that are important today for the production of base metals began as relatively unimportant placer camps. In most of those districts the potential for base-metal production was presaged by the presence of base metals in the placer concentrates. The development of placer camp into base-metal district has occurred often enough to justify the belief that a placer district in which base metals are found in the placer concentrates is a favorable area in which to prospect for lodes of various types.

The Minook Creek drainage basin comprises the major part of the Rampart Mining District, one of the older placer districts in Alaska. Throughout the years of mining, minerals that have been found in the concentrates have included cassiterite, galena, cinnabar, and nuggets of native copper and of native silver. The drainage basin as a whole can be considered, therefore, to be a favorable area in which to prospect for lodes. This investigation was made in the hope that specific areas within the Minook Creek drainage basin particularly favorable for lode deposits could be outlined by geochemistry.

One hundred-twenty samples were taken during this investigation, and fifty-nine of these contained anomalous amounts of one or more metals. Complete data on all the samples are included herein so that the prospector can draw his own conclusions from the results obtained. To the authors of this report, three parallel mineralized zones appear to be rather clearly indicated. One of these is a lead zone on the northwest side of Slate Creek; one is a copper zone on the southeast side of Slate Creek; and one is a copper-zinc zone extending across lower Chapman Creek into the headwaters of Hoosier Creek. The results also indicate the presence of other mineralized areas in which linear patterns of dispersion are not readily apparent.

LOCATION AND ACCESSIBILITY

The village of Rampart is on the Yukon River at 65° 29' N latitude and 150° 10' W longitude; it is in the east-central part of the Tanana Quadrangle. Minook Creek heads 20 airline miles south of Rampart on the north flank of Eureka Dome. From Eureka Dome it flows northeastward and, after making a broad turn to the north, follows a due north course through a remarkably straight valley to the Yukon, which it joins within a mile of the village.

Placer mining began in the Rampart District before the turn of the century, and throughout the years the Yukon River has been the principal route for freight required by the mining operations. In the early years freight came by riverboat from St. Michael on the Bering Sea; since the completion of the Alaska Railroad most freight has come by rail to Nenana and thence by riverboat down the Tanana River and up the Yukon.

From Rampart a road extends up Minook Creek four miles to a point opposite the mouth of Little Minook Creek. Formerly, a steel-girder bridge spanned Minook Creek at this place, but the bridge was washed out in 1962. In 1962 the State began construction of a road to Rampart from Eureka, which is on the Elliott Highway and is 25 miles south of Rampart. The funds appropriated for this project were spent in building the road as far as Joseph Creek (Fig. 1), and no additional funds have been made available for its completion. The approximate location of this road is shown by the dashed line on Fig. 1. If the road were completed, Rampart would be linked to the road net of Interior Alaska and would be 180 miles by road from Fairbanks.

The road north from Eureka is now passable for automobiles only to the crest of the divide between Eureka and Minook Creeks. On the hill-side from the divide down to the Minook Creek crossing (near sample 4, Fig. 1), minor damage to the road has been caused by erosion and settling of the roadbed; however, this part of the road was passable for four-wheel-drive vehicles when this investigation was made. Culverts have been washed out where samples 4, 5, and 7 were taken (Fig. 1). During the summer of 1965 prospectors working in the area were able to travel the road to its end at Joseph Creek on motorcycles built for off-the-road travel.

A winter dogsled trail goes from Rampart up the valley of Minook Creek and over the divide to Eureka. Most of the trail between the two road ends at Joseph Creek and little Minook Creek is good for foot travel in the summer. A difficult portion runs through a swampy area partly flooded by beaver dams for about two miles north of Joseph Creek. The slopes on the west side of the valley are preferable for summer walking than this particular portion of the trail.

Scheduled air transportation is provided between Rampart and Fairbanks.

GENERAL FEATURES

Minook Creek drains an area of 250 square miles. Most of its tributaries are small streams, less than 8 miles in length. Its two largest tributaries, Hunter and Hoosier Creeks, drain the northeastern part of the drainage basin and empty into Minook Creek 3 miles and 6 miles from its mouth, respectively. They drain about one-third of the total Minook Creek drainage area.

The country within the drainage basin is an area of high topographic relief, the altitudes ranging from less than 400 feet above sea level at Rampart to over 4,000 feet at the top of Baldry Mountain (Figs. 1 and 2). Narrow, steep-walled valleys are characteristic of the Minook Creek drainage basin, and they contrast to the broad valleys and rounded hillsides in most other parts of Interior Alaska. Outcrops are prevalent on the mountain tops and ridges but are sparse on hillside slopes and along the streams.

Rampart is the only settlement in the district. Its population, which has varied with the fortunes of placer mining, was reported to have been 1500 during 1898 and 1899; and it was reported to have been 49 in 1960.

GEOLOGY

The geology of the Minook Creek drainage basin has been described in two publications by the U.S. Geological Survey: Bulletin 535, A GEOLOGICAL RECONNAISSANCE OF A PART OF THE RAMPART QUADRANGLE, by Henry M. Eakin; and Bulletin 872, THE YUKON-TANANA REGION, ALASKA, by J.B. Mertie, Jr.

The oldest rocks in the report area are of Mississippian age; for mapping purposes the Survey has divided these into three units: a unit of undifferentiated non-calcareous rocks, a unit of limestones, and a unit of interbedded volcanic and sedimentary rocks, which has been named the Rampart Group. The first unit is composed largely of chert, conglomerate, greenstone, schist, and phyllite. The second unit - crystalline limestone - is interbedded with the first. These two units form a belt of rock that trends across the Minook Creek drainage basin in a northeasterly direction. On the west side of the Minook Creek valley, they constitute the bedrock from the extreme headwaters north to a point nearly opposite the mouth of Hoosier Creek; on the east side of the valley they constitute the bedrock from Chapman Creek to Hoosier Creek. All of these rocks have undergone metamorphism, and in general the rocks in the western part of the drainage area exhibit a higher degree of metamorphism than those in the eastern part.

The Rampart Group is younger than the other two units and probably is of upper Mississippian age. The volanic rocks in the group include basaltic lava flows, tuffs, and greenstone breccias. The sedimentary rocks in the Rampart Group include chert, shale, slate, and sandy beds. The sandy beds include sandy shales and a few thin beds of sandstone. Limestone is found in a few places; it is interbedded with calcareous grit composed of pebbles of greenstone cemented with calcite. This whole assemblage of rocks is cut in places by diabase dikes. The rocks of the Rampart Group overlie the other two Mississippian units and form the bedrock from the Yukon River as far south as Hoosier Creek.

After the Mississippian the next-oldest rocks in the report area are Cretaceous meta-sediments; these include shales, argillite, and slates interbedded with quartzite and quartzite conglomerate. The quartzite conglomerates are composed of pebbles of chert, vein quartz, quartzite, and limestone in a matrix of quartzite. The Cretaceous rocks lie southeast of upper Minook Creek. They are found on the east side of the Minook Creek valley as far north as Chapman Creek, and they extend northeastward across Chapman Creek and into the headwaters of Hoosier Creek. On the ridge south and southeast of the head of Minook Creek, the dominant rock in the Cretaceous sequence is a black graphitic argillite that grades in places into black slate.

Early Tertiary sedimentary rocks have been found near the mouth of Russian Creek (Fig. 3), along the southeast bank of the Yukon River from the mouth of Minook Creek to a point two miles upstream, and in a small area in the Minook Creek valley below the mouth of Hunter Creek. These rocks include conglomerate, grit, shale, and impure lignites. Late Tertiary deposits of unconsolidated gravel form the high bars along the Minook Creek valley, such as Yukon, Idaho, California, and McDonald Bars (Figs. 2 and 3).

Only one body of intrusive rock has been mapped within the report area. This is a body of monzonite and quartz monzonite that forms the top of Elephant Mountain (Fig. 1). A few similar but smaller intrusives have been mapped outside the report area in the Cretaceous rocks. Many dikes, sills, and other small intrusives are known in the area, but they are too small to be shown on any of the published geologic maps. Float in streams throughout the area indicates that these small intrusives are numerous and widespread, not only in the Cretaceous rocks but also in those of Mississippian age.

MINERAL DEPOSITS

Gold was discovered on Minook Creek in 1893, and systematic placer mining began in 1896. Other creeks in the district that have been productive are Hunter, Little Minook, Little Minook Jr., Hoosier, Ruby, Slate, and Chapman Creeks. Three or four placer mining operations are still active in the district each summer.

No production from lode deposits has been reported from the Rampart District. Some exploration work has been done on a manganese deposit (psilomelane) west of Baldry Mountain outside the report area. Another manganese deposit (rhodochrosite or rhodonite) crops out on Little Minook Creek a short distance downstream from where sample 112 was taken (Fig. 3). Hematite-bearing rock is common in gravel bars on Hunter Creek; a sample of the rock collected during this investigation contained 5.2 per cent iron. Two stibnite prospects have been reported in or near the report area; one in the headwaters of Joseph Creek and the other in the headwaters of Chapman Creek.

Minerals found in concentrates from placer mining provide a clue to types of lode deposits that might be found in the future. Nuggets of native silver have been reported on Ruby and Slate Creeks. Nuggets of native copper have been reported on Hunter, Hoosier, Little Minook, Ruby, and Slate Creeks. Galena has been reported on Hunter, Little Minook, Hoosier, and Ruby Creeks. Cinnabar has been reported on Hunter, Hoosier, and Little Minook Creeks, although the identification of the cinnabar from Little Minook Creek is questionable. Cassiterite has been reported on Hunter Creek. This information on placer concentrates is from a section in U.S. Geological Survey Bulletin 844-D, PLACER CONCENTRATES FROM THE RAMPART AND HOT SPRINGS DISTRICTS, by A.E. Waters, Jr., and from records of the Division of Mines and Minerals Assay Office at College. Native bismuth was identified in a sample of concentrates from Ruby Creek that was collected during this investigation.

GEOCHEMICAL INVESTIGATION

One hundred twenty samples of stream sediments were taken during this investigation. They were tested in the field for cold-extractable heavy metals following the procedure given in University of Alaska Mining Extension Bulletin No. 2, ELEMENTARY GEOCHEMICAL PROSPECTING METHODS, by Leo Mark Anthony. One minor departure from this procedure was made; paint thinner was used in place of white gasoline as a solvent for the dye solution. The samples consisted of clay, silt, sand, or fine gravel taken from beneath running water in the stream beds. The samples were dried and screened, and a minus-80 mesh portion of each sample was sent to Rocky Mountain Geochemical Laboratories of Salt Lake City to be analyzed for trace amounts of copper, lead, zinc, and molybdenum. A minus-80-mesh portion of each sample (except sample 43) also was sent to the laboratory of the Branch of Exploration Research, U.S. Geological Survey, Denver, Colorado, to be analyzed for trace amounts of tin.

Results of the field and laboratory tests are shown in Table I. The locations where the samples were taken are shown on Figs. 1, 2, and 3. Frequency distribution graphs showing the numbers of samples containing various concentrations of copper, lead, zinc, and molybdenum are included in this report. Tin analyses were reported by the laboratory to be either 3 parts per million or less than 3 parts per million. Samples were considered to contain anomalous amounts of metal if they contained as much as 55 parts per million of copper, 30 parts per million of lead, 175 parts per million of zinc, 5 parts per million of molybdenum, or 3 parts per million of tin.

The collecting of samples for this investigation began in the headwaters of Minook Creek and proceeded northward. By the time the sampling had progressed as far north as Hoosier Creek, the time allotted to the project had nearly elapsed. The investigation, therefore, was not carried into the headwater branches of Hoosier Creek, and it was carried only about two miles up Hunter Creek. Extremely high water during the time spent on Hoosier Creek prohibited fording the creek and prevented the taking of samples from tributaries coming into Hoosier Creek from the west.

RESULTS

An anomalous quantity of metal in a stream sediment sample is not, of course, an infallible sign that an ore deposit exists upstream from the sample site. Anomalies can be caused by mineral deposits below commercial grade or by a type of bedrock containing a higher-than-background amount of metal. Geochemical sampling of stream sediments, however, can indicate areas favorable for mineralization and thereby increase a prospector's chances for success.

Many samples which in this investigation proved to be anomalous when analyzed in the laboratory gave no indication of high metal content in the field test. The field test used probably is as reliable as any test based on the extraction of metal in a cold water solution (laboratory analyses ordinarily involve fusion or acid digestion). Table I shows how the field tests compare to the laboratory tests for the various samples. Where an anomaly is indicated by laboratory analysis but not by field test, any additional samples taken should be sent to a laboratory for analysis. Where the table indicates that an anomaly was detected by both the laboratory test and the field test, the field test alone probably could be used to trace the anomaly, but laboratory analyses should be obtained for at least some of the samples.

Probably any sample found to be anomalous in this investigation is worthy of some follow-up work. Comments on a few of the anomalies are included here, but the anomalies discussed are not necessarily considered to be more important than other shown on the maps.

Joseph Creek, Fig. 1, Samples 9 - 17

Zinc in anomalous amounts was detected in three tributaries to Joseph Creek from the north; three tributaries from the south carry anomalous amounts of one or more metals; and the farthest upstream sample on Joseph Creek contained anomalous amounts of copper, zinc, and molybdenum. Tributaries from the north that carry anomalous amounts of metal are all nearly a mile long. Additional stream sediment sampling would be the best means of following the anomalies in those streams, and would also be the best means of tracing the anomaly up Joseph Creek. Field tests on the samples corresponded fairly well to the laboratory analyses, and it appears that the field tests could be used successfully as a guide in additional sampling.

Lost Creek, Fig. 1, Sample 27

Only one sample was taken from Lost Creek, and it contained anomalous amounts of copper and zinc. The creek is about 3 miles long and has several tributaries upstream from the sample point. Additional stream sediment sampling would be the logical method to use in tracing this anomaly. The field test failed to indicate anomalous quantities of metal in the sample; therefore, laboratory analyses would be required. A relationship may exist between this anomaly and others to the north; this possibility is discussed on page 8.

Granite Creek, Fig. 1, Samples 29 - 42

Samples from four tributaries to lower Granite Creek from the north carried anomalous amounts of metal. Sample 37 was particularly high in zinc content, and this was the only sample in the Granite Creek drainage that gave a strong reaction in the field test. Sample 41, although not anomalous, carried near-anomalous amounts of copper, zinc, and molybdenum. The farthest upstream samples from Granite and Boulder Creeks (sample 29, 30, and 34) indicate that additional stream sediment samples should be taken in the headwater portions of those streams. Additional stream sediment samples in the Trout Creek drainage basin might further delineate the source area of the metals detected in the streams draining the south side of Baldry Mountain.

Chapman Creek, Fig. 2, Samples 45 - 53

Anomalous amounts of copper and zinc were detected in two samples from Chapman Creek, in three samples from three tributaries to lower

Chapman Creek from the south, and in one sample from a tributary to middle Chapman Creek from the north. Samples from two other tributaries from the north contained anomalous amounts of zinc. The source of the metals appears to be on the south side of the lower part of Chapman Creek and on the north side of the middle part. Field tests on the samples did not compare favorably with the laboratory analyses and, therefore, should not be relied upon in additional stream sediment sampling in this area.

Slate Creek, Fig. 2, Samples 66 - 77

Most of the samples from tributaries to Slate Creek carried anomalous amounts of metal. Copper was the dominant metal in tributaries from the southeast, and lead was the dominant metal in tributaries from the northwest. The field tests did not compare favorably with the laboratory analyses; therefore, laboratory analyses would be required for any additional stream sediment samples taken to follow up the anomalies.

Little Minook Creek, Fig. 3, Samples 109 - 111

Sample 109 contained anomalous amounts of copper and zinc, and samples 110 and 111 contained anomalous amounts of copper. Logical follow-up work on sample 109 would be the sampling of stream sediments at short intervals up Little Minook Creek. The metal could be coming from a small tributary, or it could be coming from a zone in the main valley. There is a possibility here of contamination from mine workings.

Dispersion Patterns Indicated by the Anomalies

In considering the dispersion of metals throughout the report area, it must be borne in mind that the sources of metals in stream sediment samples are upstream unknown distances from the sample points. If anomalies are projected upstream, in some instances patterns of mineralization are indicated, but in other instances they are not.

Anomalous amounts of molybdenum were found in some of the samples from Joseph and Granite Creeks but were not found outside the drainages of these two streams. Granitic rocks constitute a large part of the float in both of those streams, and the molybdenum probably is associated with the granitic rocks. Within the drainages of Joseph and Granite Creeks, the dispersion of molybdenum indicates at least three separate source areas that do not fit into any recognizable pattern. The molybdenum, therefore, probably is associated with several small, isolated, granitic intrusions.

The copper-zinc anomaly indicated by samples from the Chapman Creek drainage may be related to other copper-zinc anomalies in streams north and south of Chapman Creek. The source area for the copper-zinc in samples 47, 50, and 52 (Fig. 2) apparently lies south of the lower part of Chapman Creek. Samples 27 from Lost Creek (Fig. 1) carried anomalous amounts of copper-zinc, and the map shows a valley tributary to Lost Creek upstream from the sample point extending into the probable source area south of lower Chapman Creek. Sample 44 from Minook Creek (Fig. 2) carried anomalous amounts of copper-zinc, and the map shows two small valleys upstream from the sample point tributary to Minook Creek extending eastward into the same probable source area. Sample 65 from Goldpan Creek (Fig. 2) carried anomalous amounts of copper-zinc (and tin), and the map shows a valley tributary to upper Goldpan Creek extending southeastward far enough to reach a hypothetical source area that could be the source of the copper-zinc in sample 53 and the zinc in sample 51. If the source area on the north side of Chapman Creek is an extension of that on the south, and if it continues northeastward into the Hoosier Creek drainage, it could account for the copper-zinc in sample 98 on Hoosier Creek (Fig. 2).

A form of mineral zoning is indicated by the predominance of lead in samples from the northwest side of Slate Creek and the predominance of copper in samples from the southeast side. The source area of lead and that of copper would have to trend northeasterly in order to account for the distribution of those metals in the Slate Creek drainage. The source areas thus indicated would be approximately parallel to the copper-zinc source area indicated in the east side of Minook Creek, and all three of these source areas would be approximately parallel to the trend of the rock formations across the Minook Creek drainage basin.

TABLE I
RESULTS OF ANALYSES

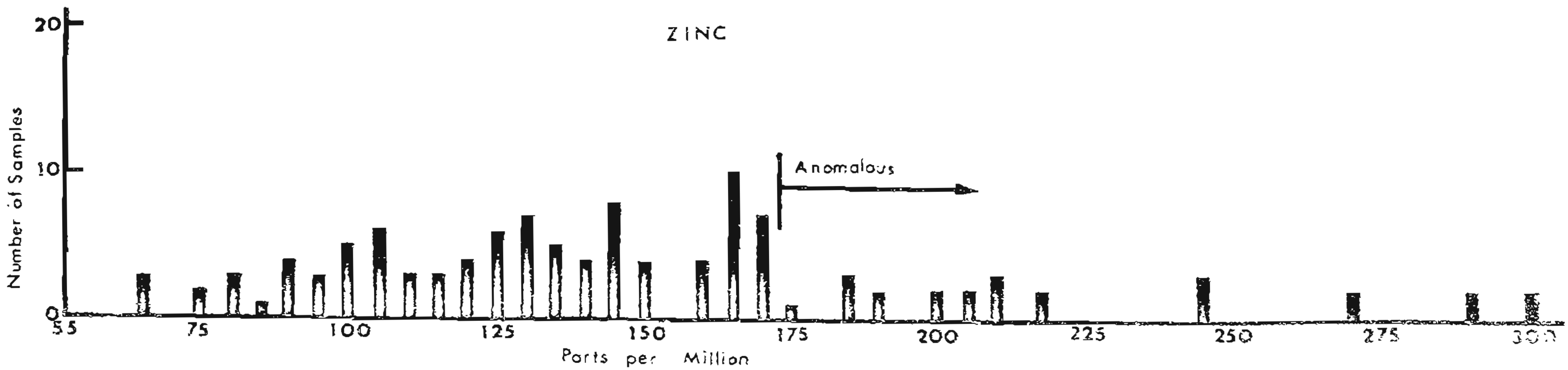
P a r t s   p e r   M i l l i o n

Map No.	Field No.	Copper	Lead	Zinc	Molybdenum	Tin*	Field Test Milliliters	Fig. No.
1	5K260	35	15	150	2		3	1
2	5H268	45	15	125	3		1	1
3	5H269	30	15	100	2	3	2	1
4	5K261	30	10	145	1		1	1
5	5K262	35	15	125	2		2	1
6	5H277	15	10	65	2		2	1
7	5K263	40	15	115	2		5	1
8	5H276	25	15	75	3		2	1
9	5K271	70	20	485	6		13	1
10	5K270	35	10	300	3		2	1
11	5K272	45	25	150	7		5	1
12	5K268	45	10	245	3		7	1
13	5K269	55	15	445	5		7	1
14	5K267	35	10	185	3		10	1
15	5K266	25	10	110	2		1	1
16	5K265	25	5	75	3		1	1
16A	5K273	85	20	160	2		6	1
17	5K264	35	10	245	3		6	1
18	5H275	30	10	90	3		3	1
19	5H270	30	15	165	2		4	1
20	5H271	30	15	105	4		1	1
21	5H272	25	15	85	2		2	1
22	5H273	20	15	100	2		1	1
23	5H274	20	15	65	3		2	1
24	5H299	50	20	115	3	3	17	1
25	5H298	45	10	130	3	3	1	1
26	5H297	40	15	165	3	3	2	1
27	5H296	60	20	190	3		1	1
28	5H295	60	20	170	3		1	1
29	5H293	55	25	130	3	3	1	1
30	5H292	45	15	100	3	3	2	1

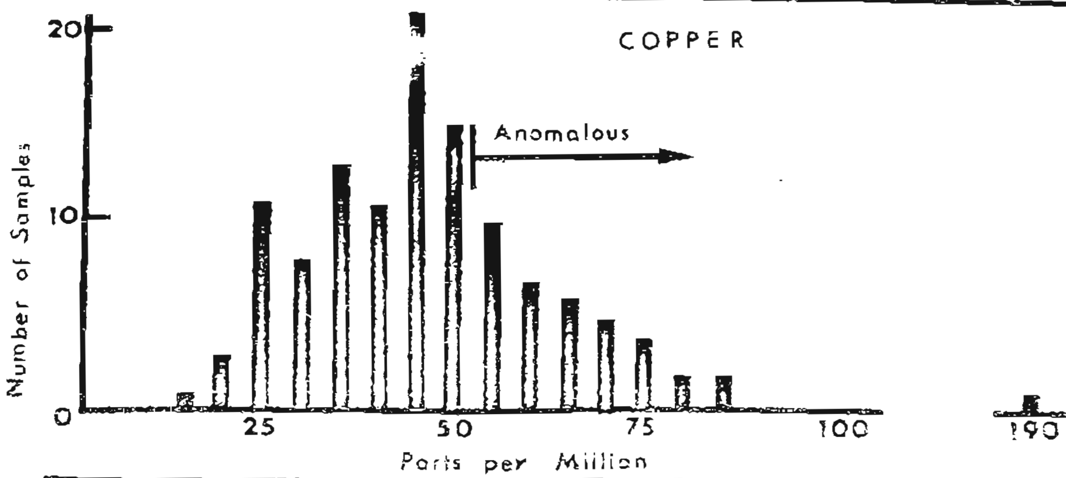
31	5H291	55	20	130	2		2	1
32	5H290	50	25	270	5		3	1
33	5H286	45	20	145	3		1	1
34	5H289	35	10	165	4		1	1
35	5H287	45	20	140	3		1	1
36	5H285	60	15	220	3		3	1
37	5H284	25	10	825	2		20	1
38	5H283	80	35	210	5		2	1
39	5H282	65	40	270	6		2	1
40	5H281	50	15	185	5		4	1
41	5H280	50	15	145	4		3	1
42	5H279	50	20	150	3		3	1
43	5H294	50	15	160	2	Not run	1	1
44	5K292	65	20	220	2		1	2
45	5K275	60	15	205	3		1	2
46	5K276	20	5	100	3		1	2
47	5K277	75	15	175	4		9	2
48	5K278	45	10	130	2		1	2
49	5K280	65	20	210	3		1	2
50	5K279	80	25	290	4		3	2
51	5K281	50	25	205	2		1	2
52	5K282	65	20	200	2		1	2
53	5K283	75	25	290	3		3	2
54	5K284	25	5	80	2		1	2
55	5K291	45	10	140	3		1	2
56	5K285	50	15	125	2		1	2
57	5K286	50	20	165	2		1	2
58	5K287	45	10	130	2		1	2
59	5K288	45	20	200	2		1	2
60	5K290	45	15	170	2		1	2
61	5K289	40	20	135	1		1	2
62	5K293	45	10	170	1		1	2
63	5K294	45	5	190	2		1	2
64	5K295	40	5	160	2	3	1	2
65	5K296	65	20	300	3	3	2	2
66	5H309	55	20	130	3		1	2
67	5H308	70	10	120	3	3	1	2
68	5H310	50	30	165	3		1	2
69	5H307	35	20	120	2	3	1	2
70	5H306	85	30	165	4	3	1	2

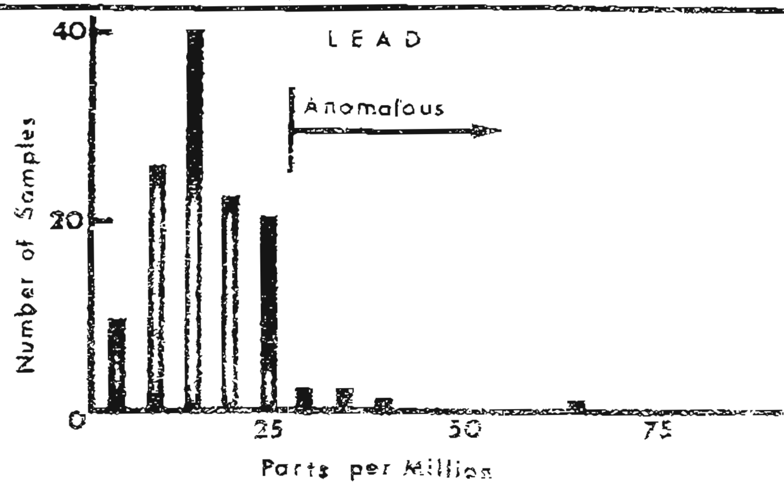
71	5H305	25	20	95	3		1	2
72	5H304	55	20	145	3		1	2
73	5H303	45	40	185	2		1	2
74	5H302	45	25	130	2		1	2
75	5H301	70	65	425	3	3	4	2
76	5H300	40	35	135	3		2	2
77	5H311	50	35	170	2		1	2
78	5K297	60	15	165	4		1	2
79	5H312	70	30	150	3		1	2
80	5K310	35	15	125	2		1	2
81	5K309	40	15	165	3		1	2
82	5K308	55	25	165	2		1	2
83	5K307	40	10	135	1		1	2
84	5K306	40	20	105	1		1	2
85	5K305	45	15	105	4		1	2
86	5K304	40	15	125	2		1	2
87	5K302	40	15	90	2		1	2
88	5K303	55	15	145	2		1	2
89	5K301	25	5	65	2		1	2
90	5K300	40	15	135	2		1	2
91	5K299	45	10	170	3		2	2
92	5K298	25	5	100	3		1	2
93	5K311	35	15	145	1		3	2
949	5K312	35	15	140	1		1	2
95	5H313	35	15	95	3		1	2
96	5H314	75	15	115	3		1	2
97	5K313	35	20	170	2		5	2
98	5H321	55	25	210	2		1	2
99	5H320	45	15	160	3		1	2
100	5H319	60	15	120	3		1	2
101	5H318	45	10	105	3		1	2
102	5H317	50	15	135	2		1	3
103	5H316	70	10	110	2		1	3
104	5H315	30	20	105	3	3	1	3
105	5H322	50	20	170	3		1	3
106	5H324	55	15	165	3		1	3
107	5H323	30	15	80	3		1	3
108	5H329	25	10	80	3		2	3
109	5H325	190	15	245	2		4	3
110	5H328	65	10	125	2		1	3

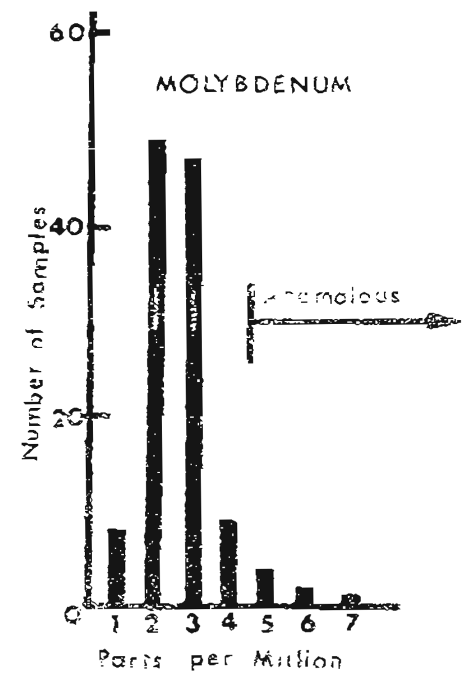
111	5H327	60	10	95	4	1	3
112	5H326	50	15	140	3	1	3
113	5K314	25	5	90	2	1	3
114	5K319	45	10	120	2	1	3
115	5K320	55	5	145	2	1	3
116	5K318	30	10	110	2	1	3
117	5K317	35	5	105	1	1	3
118	5K316	75	5	90	2	1	3
119	5K315	50	10	145	2	1	3



Note: Four samples containing over 400 ppm are not shown.







FREQUENCY DISTRIBUTION GRAPHS

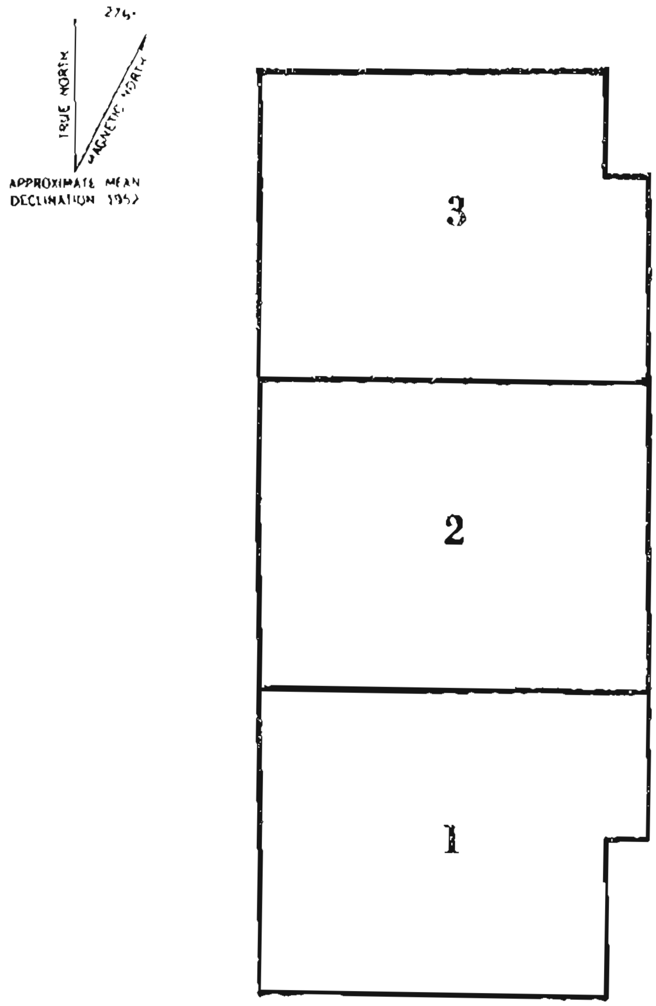


DIAGRAM
Showing Layout
of
Figs. 1, 2, & 3

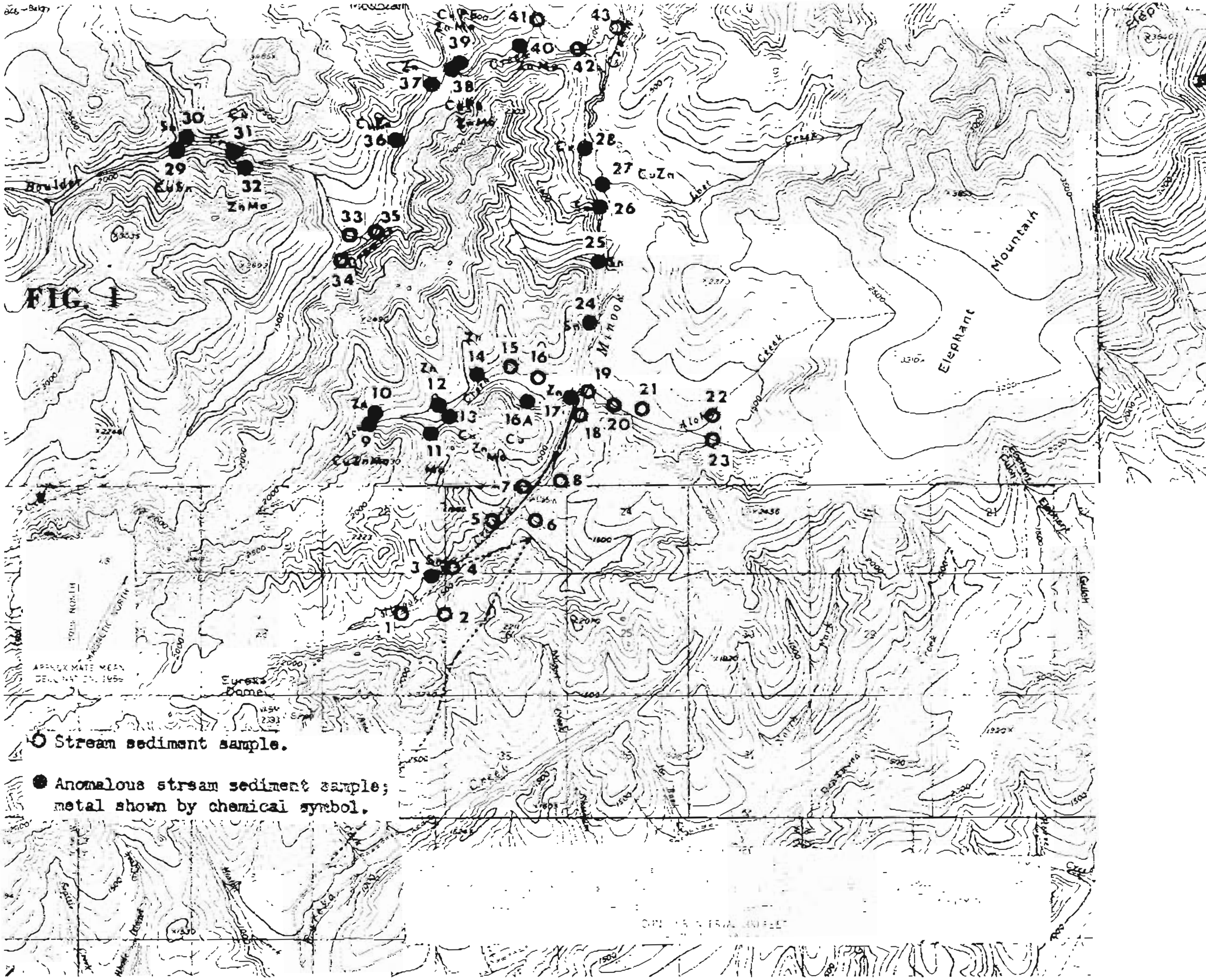
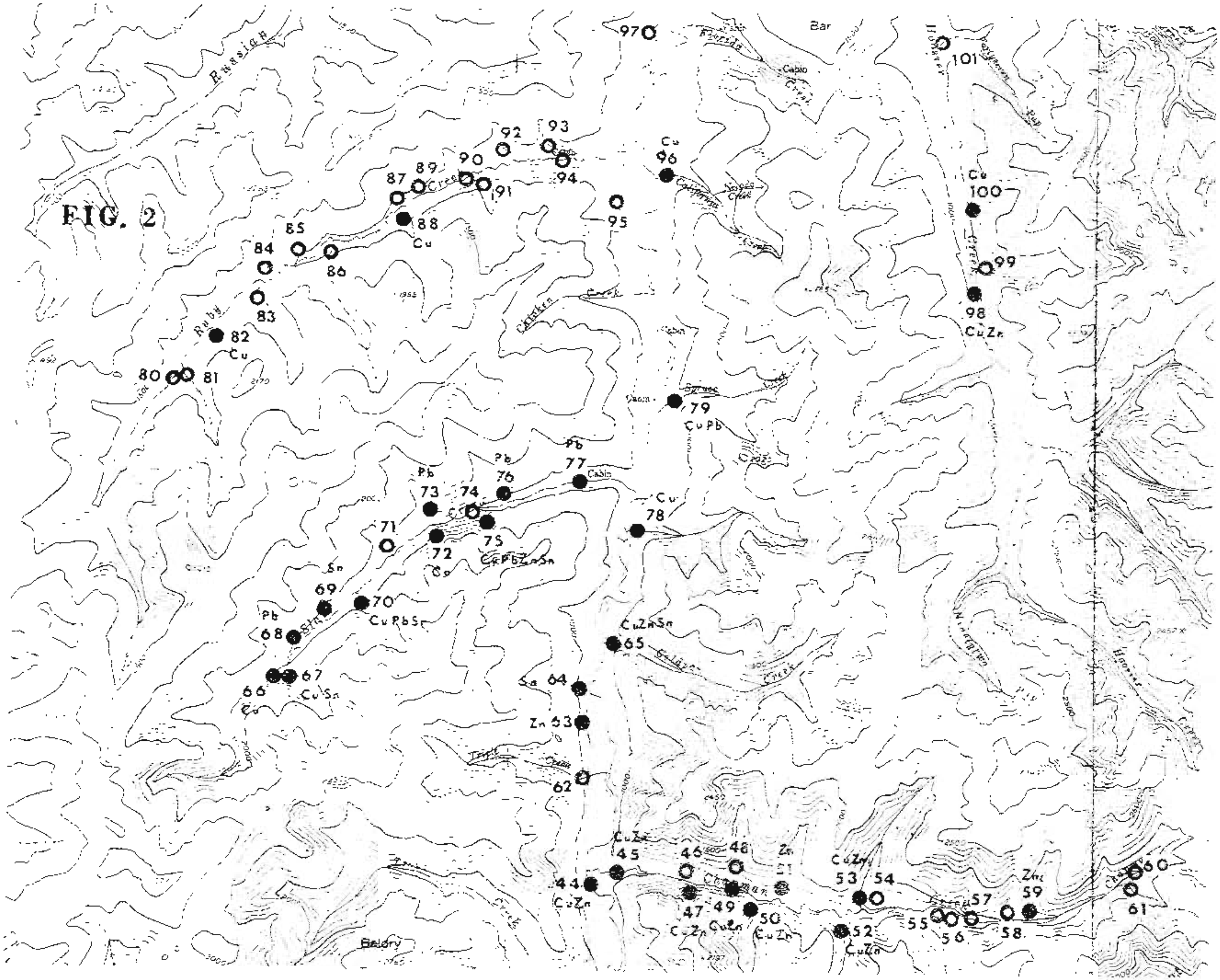


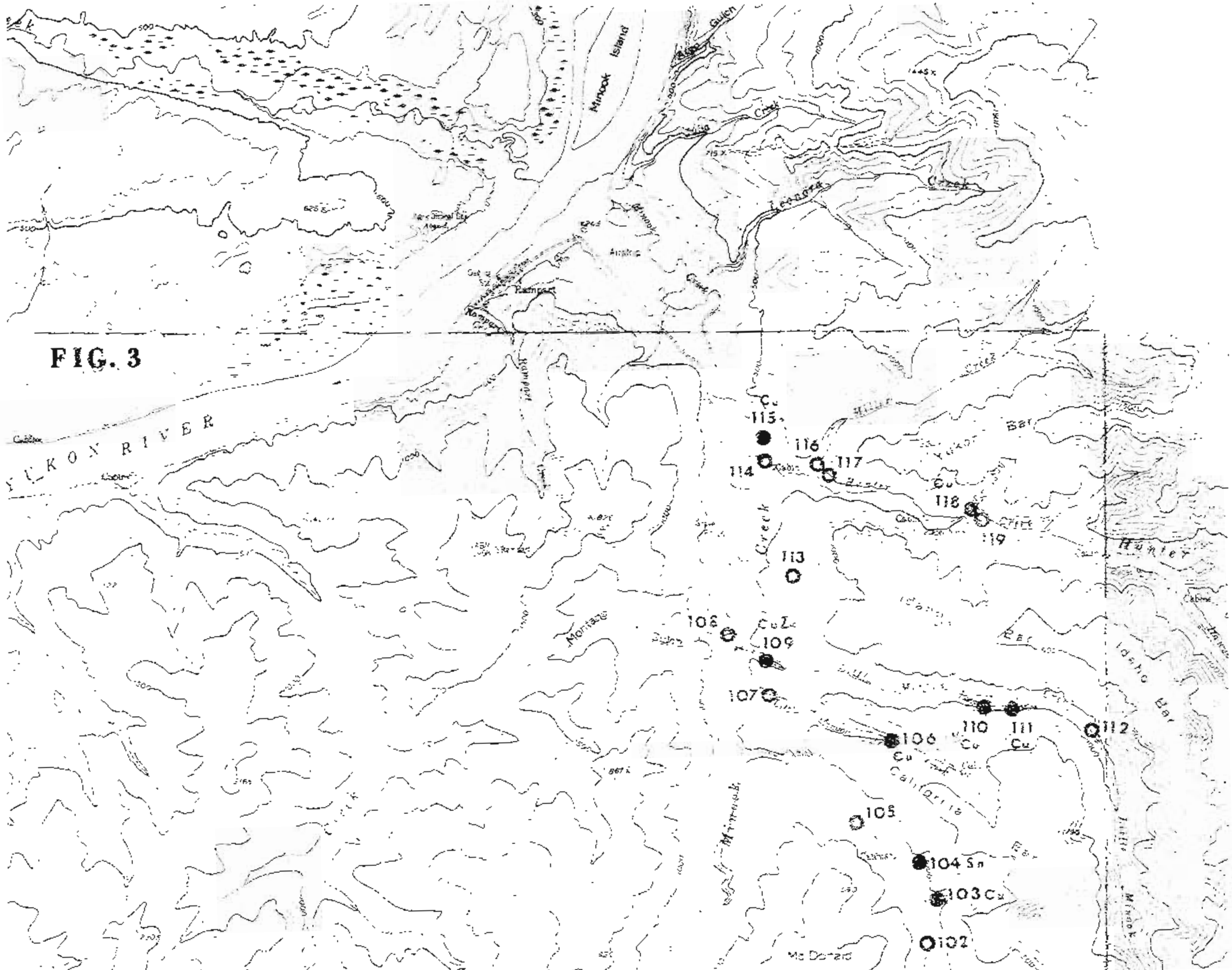
FIG. 1
Elephant Mountain
Minook
Creek
Boulder
Eureka Dome
Elephant Gulch
O Stream sediment sample.
● Anomalous stream sediment sample; metal shown by chemical symbol.

FIG. 2



Russian
Bar
Cabin
Creek
Cu
Ruby
Chicken Creek
Spruce
Creek
Pb
Cabin
Sn
CuPbZnSn
CuPbSn
CuZnSn
CuSn
Zn
CuZn
Chapman
Belory
Creek

FIG. 3


YUKON RIVER
Minook Island
Rampart
Leonora
Creek
Hunter
Creek
Idaho Bar
Little Minook
California
Minook
Montana
McDonald
102
103 Cu
104 Sn
105
106 Cu
107
108
109
Cu Zn
110 Cu
111 Cu
112
113
114
115 Cu
116
117
118 Cu
119