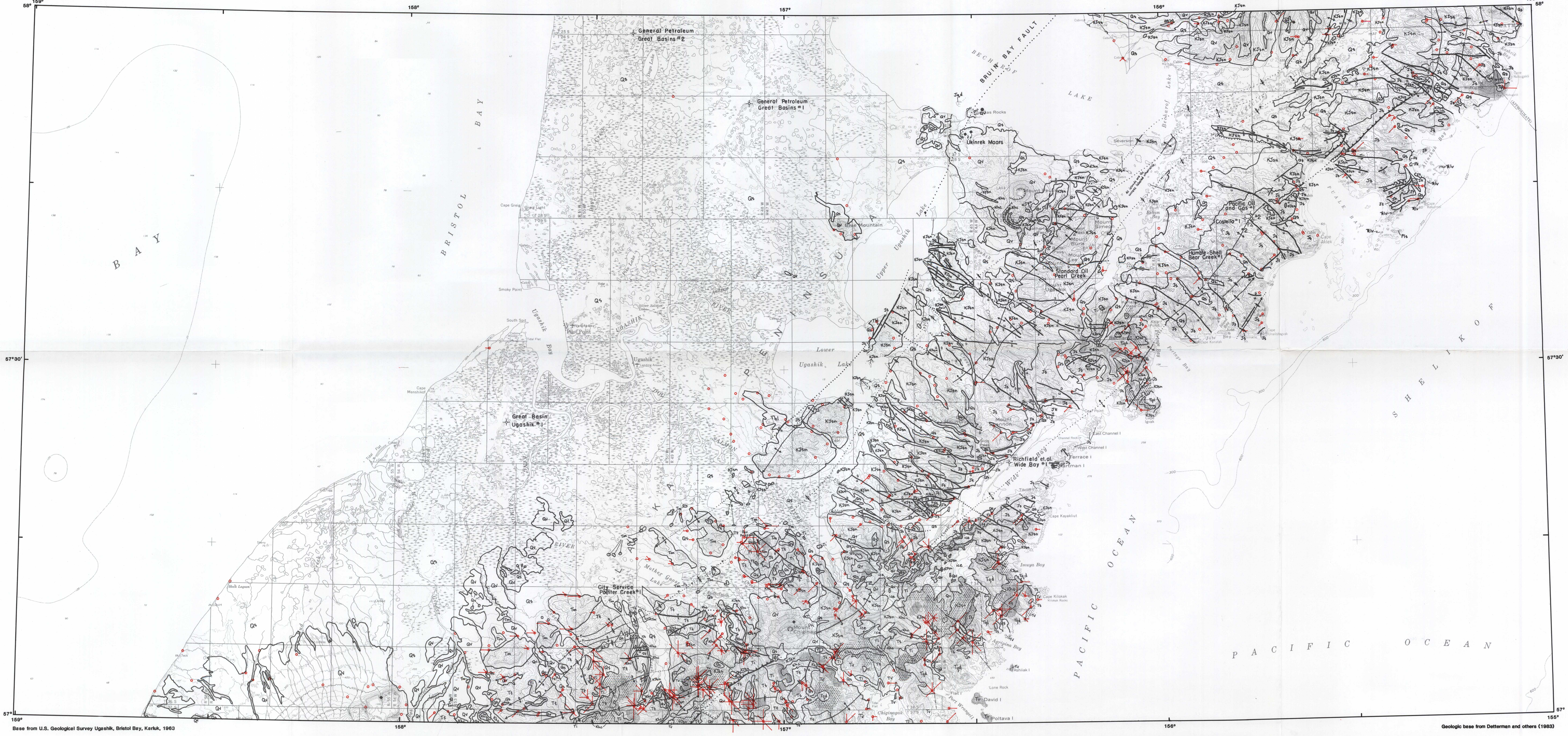
DEPARTMENT OF THE INTERIOR
U.S. GEOLOGICAL SURVEY

MISCELLANEOUS FIELD STUDIES
MAP MF-1539-G
SHEET 1 OF 2
FOLIO OF UGASHIK, BRISTOL BAY, AND WESTERN KARLUK QUADRANGLES, ALASKA



Base from U.S. Geological Survey Ugashik, Bristol Bay, Karluk, 1963

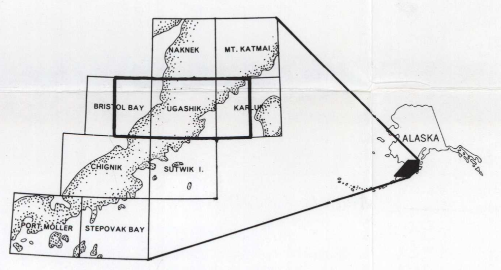
Geologic base from Detterman and others (1983)

SCALE 1:250 000

5 0 5 10 15 20 25 MILES

5 0 5 10 15 20 25 KILOMETERS

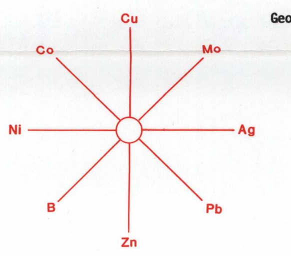
CONTOUR INTERVAL 200 FEET
NATIONAL GEODETIC VERTICAL DATUM OF 1929



Map Area

MAP A--COPPER, MOLYBDENUM, SILVER, LEAD, ZINC, BORON, NICKEL, COBALT

EXPLANATION



Geochemical sample site--Vectors centered around the sample locality showing anomalous concentrations of eight selected elements. Each vector of the eight-sided star diagram represents a specific element, and the length of the vector indicates the concentration range of that element present in the sample. Concentration ranges are indicated on the histograms in figure 1.

NOTE: The following correlation, description of map units, and list of symbols is for the geologic base map shown here in gray.

CORRELATION OF MAP UNITS

SURFICIAL DEPOSITS AND SEDIMENTARY ROCKS	VOLCANIC ROCKS	INTRUSIVE ROCKS		
Qs	Qv		Holocene and Pleistocene	QUATERNARY
Tbl	Tv	Tqd, Ti	Pliocene to Oligocene	TERTIARY
	Tm		Oligocene and Eocene	
Tt			Eocene and Paleocene	
Khc			Upper Cretaceous	CRETACEOUS
KJsn			Lower Cretaceous and Upper Jurassic	CRETACEOUS AND JURASSIC
Js			Middle Jurassic	JURASSIC
Jk		Jqd	Lower Jurassic	
Jt				
Ŧlv			Upper Triassic	TRIASSIC
Pls			Upper Permian	PERMIAN

DESCRIPTION OF MAP UNITS

SURFICIAL DEPOSITS AND SEDIMENTARY ROCKS

Qs — SURFICIAL DEPOSITS (HOLOCENE AND PLEISTOCENE) - Unconsolidated alluvium, alluvial fans, and glacial, marine, lake, swamp, eolian, and landslide deposits; mainly silt, sand, gravel, pumice, and rock fragments

Tbl — BEAR LAKE FORMATION (MIOCENE) - Sandstone, siltstone, shale, minor coal, and conglomerate; nonmarine

Tt — TOLSTOI FORMATION (EOCENE AND PALEOCENE) - Sandstone, conglomerate, siltstone, shale, coal, and tuff; dominantly volcaniclastic and nonmarine

Khc — HOODOO AND CHIGNIK FORMATIONS, UNDIVIDED (UPPER CRETACEOUS) - Hoodoo Formation: dark rhythmically-bedded siltstone and shale, minor thin sandstone; deep-water marine. Chignik Formation: sandstone, conglomerate, siltstone, and shale; mainly shallow marine

KJsn — STANIUKOVICH AND NAKNEK FORMATIONS, UNDIVIDED (LOWER CRETACEOUS AND UPPER JURASSIC) - Staniukovich Formation of Late Jurassic and Early Cretaceous age: thin-bedded feldspathic sandstone, commonly laumontitic; minor siltstone and shale. Naknek Formation of Late Jurassic age: thin-bedded sandstone, siltstone, and dark shale with limestone concretions in upper part. Massive arkosic sandstone and conglomerate in lower part; abundant granitic- and metamorphic-rock clasts in conglomerate. Upper part marine; lower part nonmarine fluvial

Js — SHELIKOF FORMATION (MIDDLE JURASSIC) - Dark siltstone and shale with limestone concretions, sandstone, and conglomerate; nonmarine to near-shore marine, and deep-water turbidite

Jk — KIALAGVIK FORMATION (MIDDLE AND LOWER JURASSIC) - Sandstone, siltstone, mudstone, and shale; mainly shallow water marine

Jt — TALKEETNA FORMATION (LOWER JURASSIC) - Tuffaceous sandstone, siltstone, and limestone; minor bedded tuff

Pls — LIMESTONE (UPPER PERMIAN) - Light-gray massive crystalline limestone

SEDIMENTARY AND VOLCANIC ROCKS

Ŧlv — LIMESTONE AND VOLCANIC ROCKS (UPPER TRIASSIC) - Light- to dark-gray thin-bedded to massive limestone, limestone conglomerate, and basalt

VOLCANIC ROCKS

Qv — VOLCANIC ROCKS (HOLOCENE AND PLEISTOCENE) - Block and ash flows, debris flows, volcanic mud flows, cinder cones, and andesitic and dacitic lava flows; includes minor hypabyssal rocks

Tv — VOLCANIC ROCKS (PLIOCENE TO OLIGOCENE) - Basalt, andesite, and dacite lava flows, volcanic breccia, and rubble flows; locally includes hypabyssal rocks

Tm — MESHIK FORMATION (OLIGOCENE AND EOCENE) - Basalt flows, volcanic rubble flows, and lahars; locally minor volcanogenic sedimentary rocks

INTRUSIVE ROCKS

Tqd — QUARTZ DIORITE (PLIOCENE TO OLIGOCENE) - Agripina Bay pluton; hornblende-biotite and pyroxene-biotite quartz diorite; medium to coarse grained

Ti — INTRUSIVE ROCKS (PLIOCENE TO OLIGOCENE) - Diorite, quartz diorite, hypabyssal andesite and dacite

Jqd — QUARTZ DIORITE (MIDDLE AND LOWER JURASSIC) - Medium to coarse grained, hornblende and biotite bearing; part of the Alaska-Aleutian Range batholith

GEOLOGIC MAP SYMBOLS

CONTACT--Dotted where concealed

FAULT--Dotted where concealed; queried where probable. U, upthrown side; D, downthrown side. Arrows indicate relative lateral movement

THRUST OR HIGH-ANGLE REVERSE FAULT--Dotted where concealed; sawteeth on upper plate

FOLDS--Showing trace of axial plane; dotted where concealed; queried where probable. Arrow indicates direction of plunge

Anticline

Syncline

LINEAMENT

VOLCANIC CRATER

VOLCANIC VENT OR CINDER CONE (OTHER THAN WITHIN CRATERS)

HORNFELS

ALTERATION--Includes sericitic alteration and silicification

EXPLORATORY DRILL HOLE

OIL SEEPS

HOT SPRING

COLD SPRING

GAS SEEP--Carbon dioxide

INTRODUCTION

The U.S. Geological Survey is required by the Alaska National Interest Lands Conservation Act (ANILCA, Public Law 96-487) to survey certain Federal lands to determine their mineral resource potential. Results from the Alaska Mineral Resource Appraisal Program (AMRAP) must be made available to the public and be submitted to the President and the Congress. This report presents the results of a geochemical survey of the Ugashik, Bristol Bay, and western Karluk quadrangles, Alaska.

The geologic setting of the study area, on the Alaska Peninsula, is that of a volcanic arc. At least two-thirds of the study area is covered either by Quaternary alluvial and glacial deposits or by Quaternary volcanic rocks. The Pacific Ocean side of the study area is predominately underlain by Jurassic, Cretaceous, and Tertiary marine and nonmarine clastic sedimentary rocks that are, in places, intruded by, or covered by, Tertiary diorite and quartz diorite and associated extrusive equivalents. The geologic base map is from Detterman and others (1983). The area is favorable for the occurrence of base- and precious-metal deposits, in particular for disseminated sulfide deposits associated with calc-alkaline porphyrys. Contact-metamorphosed rocks and hydrothermally altered rocks are common near Tertiary volcanic-plutonic centers, most of which are exposed in the southeastern part of the study area (Detterman and others, 1983). MacKevett and Holloway report known mineralized rock at Puale Bay and Cape Kubugakli in the Karluk quadrangle (MacKevett and Holloway, 1977, p. 16), as well as several copper-molybdenum and molybdenum porphyry systems in the Ugashik quadrangle (MacKevett and Holloway, 1977, p. 35). At the time the field studies were in progress, Bear Creek Mining Company was actively evaluating the mineralized rock at the Mike and Rex prospects.

A reconnaissance exploration geochemical study was undertaken during the 1979 and 1980 field seasons. Two different media were *sampled*: (1) stream sediments, and (2) heavy-mineral concentrates panned from the stream sediments. The minus-80-mesh stream-sediment medium reflects changes in bedrock geology and geochemistry and may also reveal extensive areas of exposed mineralized rock, whereas the nonmagnetic fraction of the heavy-mineral-concentrate medium concentrates the ore-related minerals present and may be useful in delineating areas of poorly exposed or buried mineralized rock. We panned down one 14-in. gold pan full of minus-2-mm stream sediment at 569 sample sites. This sample was further processed in the laboratory with heavy liquids to remove the light-mineral fraction (sp. gr. <2.8) and through a magnetic separation process to remove magnetite as well as many of the most magnetic mafic minerals.

The nonmagnetic heavy-mineral fraction analyzed for this study contained some rock-forming minerals having a high specific gravity, such as apatite, zircon, rutile, and sphene; the sulfide, sulfosalt, and some oxide minerals; scheelite; and several of the accessory minerals associated with mineralization and alteration, such as fluorite, barite, epidote, and tourmaline. Analyses were carried out by the semiquantitative spectrographic method described by Grimes and Marranzino (1968) and Motooka and Grimes (1976). A detailed description of the geochemical sampling, sample preparation, and analytical methods utilized in the reconnaissance study was presented, along with the tabulated geochemical data and sample locality maps, in Detra and others (1981).

This report is one of a series of three reports that graphically present selected geochemical and mineralogical data in map format. This report presents geochemical results from the analysis of the nonmagnetic heavy-mineral-concentrate medium, MF-1539-F (Church and others, 1988) presents the geochemical results from the analysis of the minus-80-mesh stream sediments, and MF-1539-H (Frisken and others, 1988) presents mineralogical distributions based on microscopic identification of mineral grains from the nonmagnetic heavy-mineral-concentrate samples. An interpretive report (Church, Frisken and Wilson, in press) delineates selected areas of interest within the study area, interprets the significance of the geochemical and mineralogical signatures of these anomalous areas, and explains how these signatures might relate to mineral systems and ore-deposit models. The interpretive report is based on a study of all of the data available to the authors: the stream-sediment geochemistry (MF-1539-F; Church and others, 1988), the mineralogy (MF-1539-H; Frisken and others, 1988) and geochemistry (this report) of the heavy-mineral concentrates panned from stream sediments, rock geochemical data (MF-1539-C; Wilson and O'Leary, 1986, 1987), the geologic map of the study area (MF-1539-A; Detterman and others, 1983), the magnetic anomaly map of the study area (MF-1539-D; Case and others, 1988), relevant published mineral occurrence maps and data compiled from references (Cobb, 1978, 1980, 1981), and published mineral assessment studies of the contiguous Chignik and Sutwik Island quadrangles to the south (Cox and others, 1981).

A statistical summary of the geochemical data determined from the nonmagnetic heavy-mineral-concentrate medium and selected percentiles for each element are given in table 1. The eight elements for which data are shown on map A of this report are the same group of elements shown on the stream-sediment geochemical map (MF-1539-F; Church and others, 1988). A second suite of generally less abundant elements, selected to reflect sulfide mineralization expected in this geologic environment, is shown on map B. Histograms of these data are shown in figures 1 and 2. Elements that show strong geochemical coherence, for example molybdenum and tungsten, or trace metals that would readily substitute for a more abundant element, such as silver for lead, are shown on the corresponding vector on map B. The anomalous element concentrations are shown by vectors that radiate from sample localities indicated by small circles. The vectors are subdivided into three lengths that approximate the 90th, 95th, and 98th percentile distributions of the log-normalized data (see the histograms of the data, fig. 1, map A; fig. 2, map B).

Because of the mineralogical and geochemical diversity of the nonmagnetic fraction of the heavy-mineral suite, the data sets for all of the elements plotted are censored, that is the shape of the distribution of these elements is artificially limited by the sensitivity of the analytical method. Boron has several modes, and barium probably has a mode at concentrations greater than 10,000 ppm. The data for niobium, cobalt, copper, barium, and nickel approximate a log-normal curve; the distribution for nickel is negatively skewed, whereas for copper, barium, and cobalt it is positively skewed. Minor modes at the high concentration ranges of silver, arsenic, copper, nickel, lead, and tin appear to reflect mineralization. The upper mode was plotted for these elements. The resulting star diagrams not only show the presence of anomalous concentrations of these elements, but can also be used to indicate the geochemical signature of particular mineral deposits. These signatures are indicated by patterns in the individual stars representing suites of elements characteristic of particular types of mineral deposits. Clusters of similar stars on the geochemical maps may represent one or more deposits having large areal exposure.

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TABLE 1.--Statistical summary of nonmagnetic heavy-mineral-concentrate data, Ugashik, Bristol Bay, and western Karluk quadrangles, Alaska

[Method of analysis: semiquantitative emission spectrography; values reported in ppm except for Mg, Ca, Fe, and Ti reported in percent. Leaders (--) denote no data]

Element	Data based on the qualified population: DR[1]	Number of Samples: N[2]	L[3]	G[4]	Data based on the unqualified population: Number of values	Range of values	Geometric mean	Geometric deviation	Arithmetic mean	Standard deviation	Percentile distribution based on samples analyzed: 90th	95th	98th
Mg	1.000	0	0	0	569	0.07-20	1.4	3.5	3.1	4.1	9.4	12	16
Ca	1.000	0	0	0	569	0.1-30	7.4	2.3	9.3	5.0	15	17	23
Fe	0.989	0	0	6	563	0.7-50	5.3	2.3	7.7	8.6	17	30	48
Ti	0.588	0	0	234	335	0.15-2	1.1	1.8	1.3	0.59	--	--	--
B	0.946	0	6	25	538	20-5,000	250	3.4	540	930	2,200	5,100	--
Be	0.035	161	388	0	20	2.0-3.0	2.1	1.2	2.2	0.37	--	--	--
Sr	0.941	0	28	0	541	200-7,000	410	1.7	500	520	760	1,000	1,600
Ba	0.856	0	0	82	487	70-10,000	520	2.8	1,000	1,700	--	--	--
La	0.991	0	5	0	564	50-2,000	140	2.0	180	170	350	460	610
Y	0.996	1	1	0	567	20-1,500	230	2.5	340	260	710	790	950
Zr	0.137	0	0	491	78	200-2,000	1,300	1.8	1,400	600	--	--	--
Nb	0.538	108	155	0	306	50-200	81	1.5	90	43	127	162	--
Th	0.004	564	3	0	2	300-2,000	--	--	--	--	--	--	--
Sc	0.968	1	4	13	551	10-200	53	1.9	64	41	130	190	--
Mn	1.000	0	0	0	569	100-5,000	1,200	1.8	1,400	640	2,400	2,500	3,200
V	1.000	0	0	0	569	30-1,000	240	1.8	290	178	530	630	750
Cr	0.993	0	2	2	565	20-10,000	310	4.0	830	1,400	2,300	3,600	6,200
Ni	0.917	21	26	0	522	10-700	70	2.3	98	87	190	260	360
Co	0.917	1	46	0	522	10-700	36	2.6	61	88	130	220	380
Cu	0.745	22	123	0	424	7-10,000	58	4.6	270	810	380	1,100	2,200
Mo	0.040	546	0	0	23	10-1,500	54	4.6	180	346	--	--	41
W	0.025	543	12	0	14	100-1,500	250	2.3	360	380	--	--	130
Sn	0.378	335	19	0	215	20-500	39	1.8	48	46	53	69	81
Bi	0.017	557	2	0	10	20-500	44	2.7	85	150	--	--	--
Au	0.023	552	4	0	13	20-1,000	140	4.2	310	370	--	--	--
Pb	0.540	129	133	0	307	20-50,000	65	3.5	330	2,900	180	400	1,000
Ag	0.281	393	16	0	160	1-500	5.9	3.1	15	47	7.3	13	34
Zn	0.088	510	7	2	50	500-20,000	1,600	2.9	3,000	4,300	--	1,200	4,300
Cd	0.025	555	0	0	14	50-1,000	162	2.4	240	260	--	--	77
As	0.069	527	3	0	39	500-10,000	1,200	2.0	1,600	1,600	--	790	1,600

[1] Detection ratio (DR) is the number of uncensored values divided by the total number of samples analyzed for a given element.
[2] N is the number of samples in which concentrations could not be detected at the lower determination limit.
[3] L is the number of samples with concentrations reported as observable, but which are less than the lower determination limit.
[4] G is the number of samples with concentrations reported as observable, but which are greater than the upper determination limit.

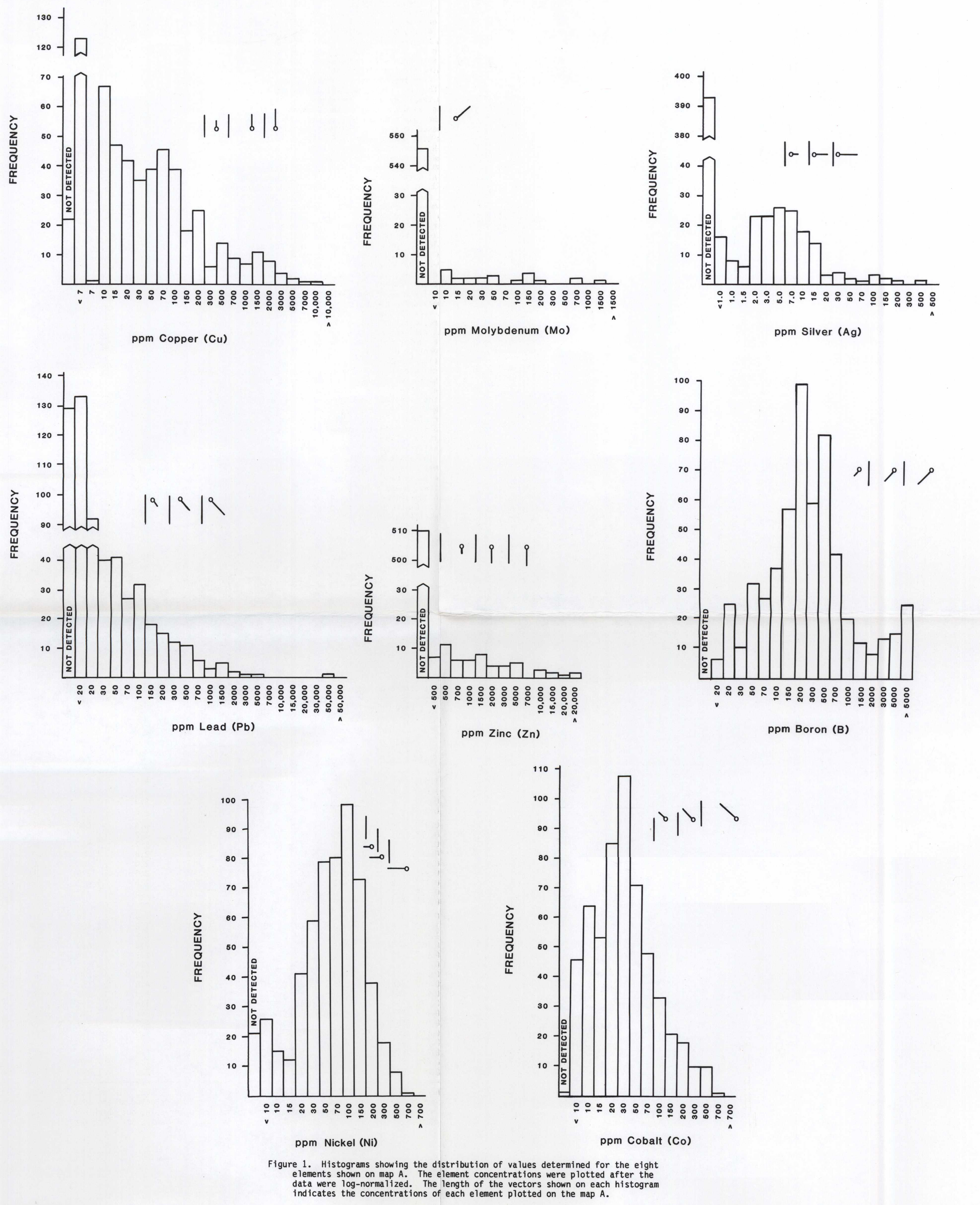

Figure 1. Histograms showing the distribution of values determined for the eight elements shown on map A. The element concentrations were plotted after the data were log-normalized. The length of the vectors shown on each histogram indicates the concentrations of each element plotted on the map A.

GEOCHEMICAL MAP SHOWING THE DISTRIBUTION OF SELECTED ELEMENTS DETERMINED IN NONMAGNETIC HEAVY-MINERAL CONCENTRATES FROM THE UGASHIK, BRISTOL BAY, AND WESTERN KARLUK QUADRANGLES, ALASKA

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