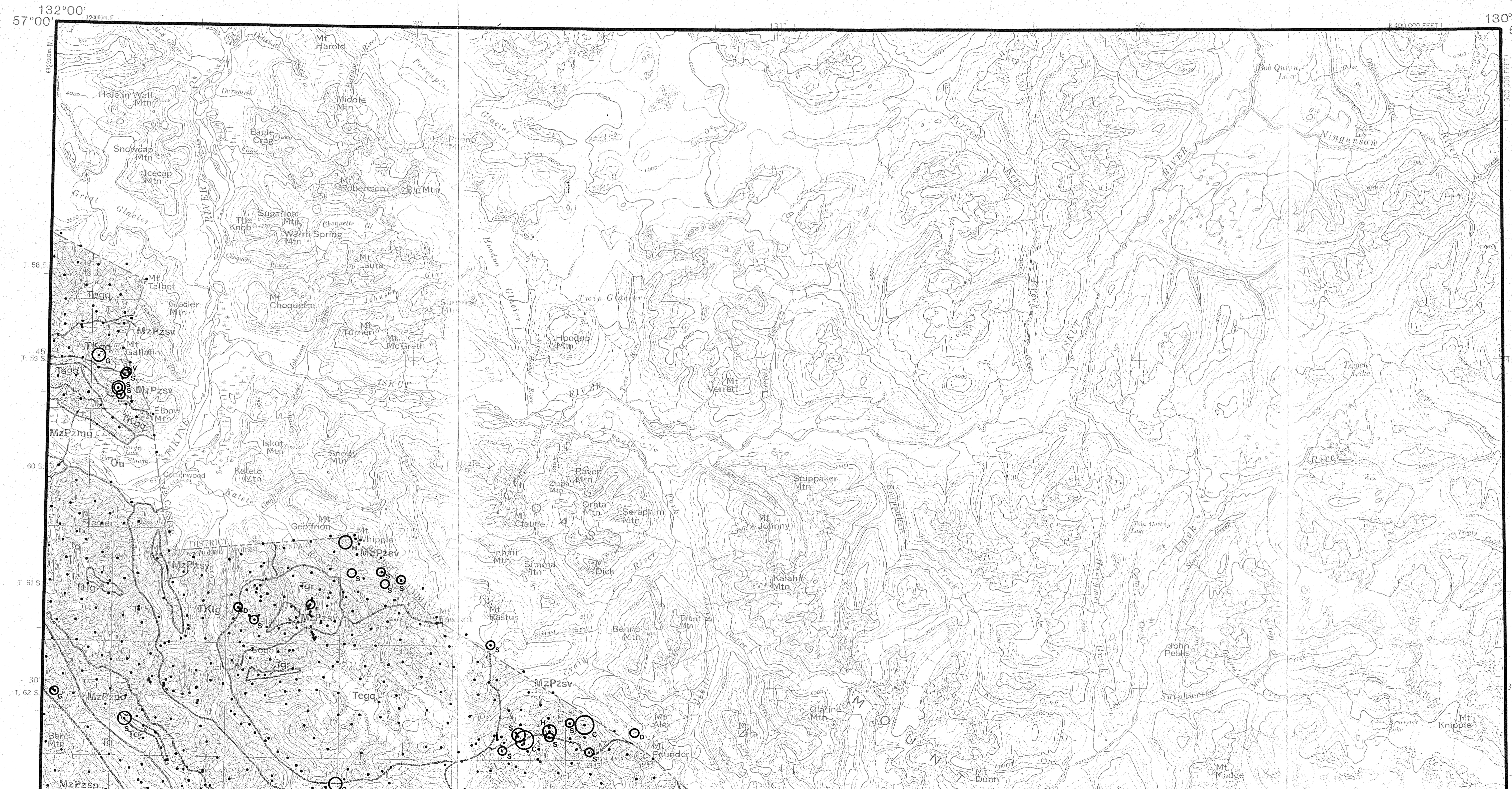
DEPARTMENT OF THE INTERIOR
UNITED STATES GEOLOGICAL SURVEY

OPEN-FILE REPORT
81-728-D
sheet 1 of 4

FOLIO OF THE BRADFIELD CANAL QUADRANGLE, ALASKA
KOCH AND ELLIOTT--GEOCHEMISTRY- Cu

COPPER IN ROCK SAMPLES
(atomic-absorption determinations)

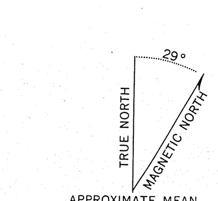


Base from USGS 1:250,000 topo series: Bradfield Canal, 1955, ALASKA-CANADA.

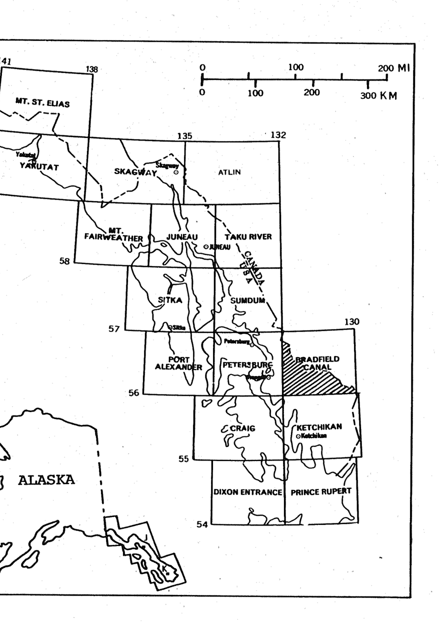
ROCK SAMPLES

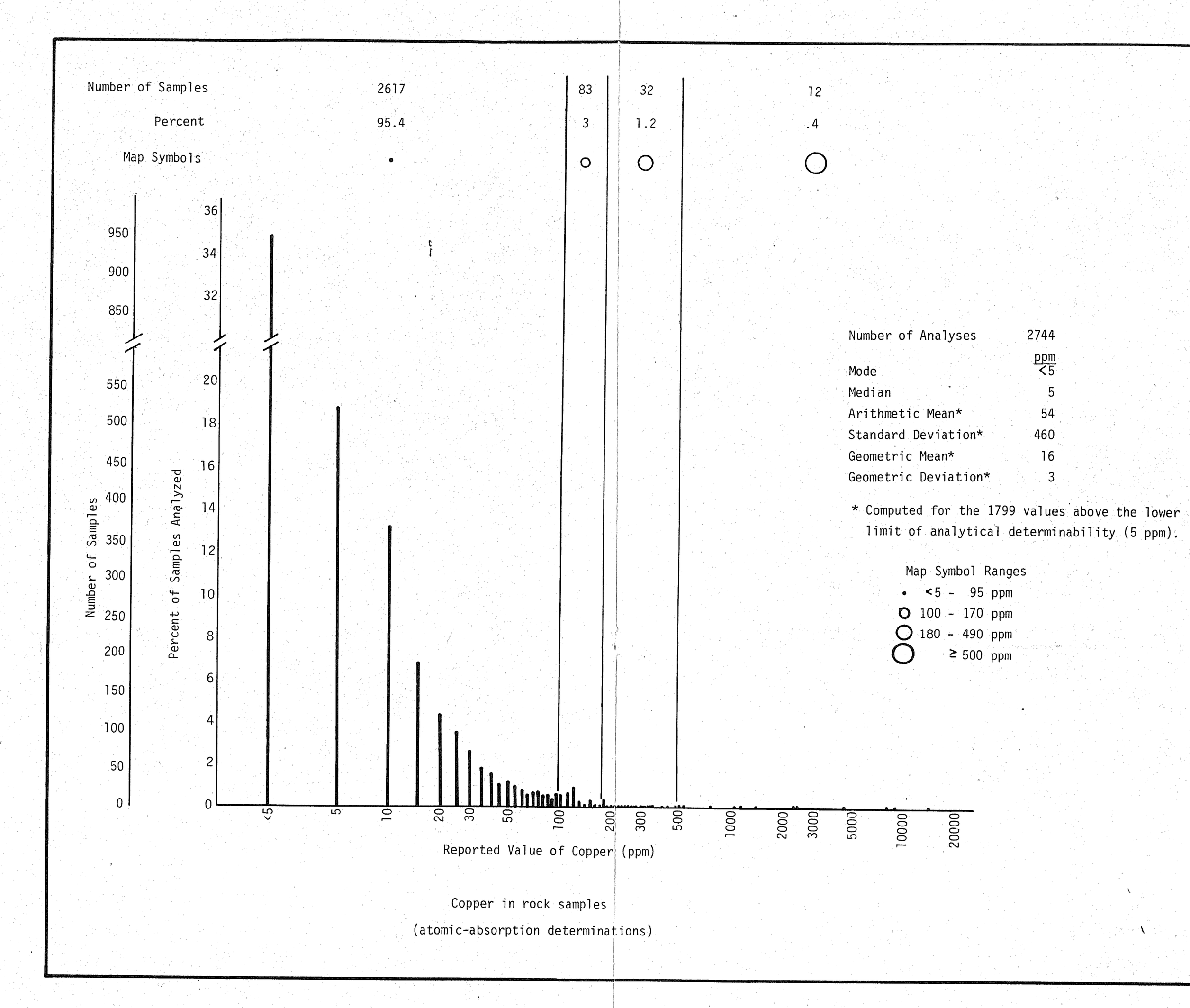
Geology by H. C. Berg, D. A. Brew, A. L. Clark, W. H. Condon, J. E. Decker, M. F. Diggles, G. C. Dunne, R. L. Elliott, J. D. Gallinatti, M. H. Herdrick, S. M. Karl, R. D. Koch, M. L. Miller-Hoare, R. P. Morrell, J. G. Smith, and R. A. Sonnevil, 1968-1979.

SCALE 1:250 000
5 0 5 10 15 20 25 MILES
5 0 5 10 15 20 25 KILOMETERS
CONTOUR INTERVAL 200 FEET
DATUM IS MEAN SEA LEVEL



APPROXIMATE MEAN DECLINATION, 1955





Copper in rock samples
(atomic-absorption determinations)

KEY TO LITHOLOGY GROUP SYMBOLS

A - ALKALI-FELDSPAR GRANITE - includes related dikes

B - BASALT and ANDESITE - includes dikes and flows, and lamprophyre dikes

C - CALCSILICATE and SKARN

D - DIORITE and GABBRO - includes minor metadiorite, hornblendite, and ultramafic rocks

F - FELSITE - some quartz-porphyritic. Includes dikes, flows(?), and breccias

G - GRANITIC ROCKS - mainly massive and foliated quartz monzonite, granodiorite, and quartz diorite, with lesser alaskite, aplite, and pegmatite

H - HORNBLENDE-RICH SCHIST and GNEISS - includes amphibolite, greenschist, and other mafic metamorphic rocks

M - MIGMATITE and ORTHOGNEISS - includes granitic gneiss (eg: granodiorite gneiss, quartz diorite gneiss, etc.)

S - SCHIST and GNEISS - mainly pelitic and quartzofeldspathic schist and gneiss, and lesser non-schistose metasedimentary rocks

V - VEINS

Unit Descriptions

Qu	UNCONSOLIDATED DEPOSITS, UNDIVIDED (Quaternary)
QTb	BASALT (Quaternary and Tertiary?)
Tgr	ALKALI-FELDSPAR GRANITE WITH ASSOCIATED QUARTZ-PORPHYRITIC RHYOLITE DIKES AND FLOWS(?) (Miocene?)
Tgb	BIOTITE-PYROXENE GABBRO, LOCALLY CONTAINS HORNBLENDE AND/OR OLIVINE (Miocene)
Telg	LEUCOCRATIC QUARTZ MONZONITE AND GRANODIORITE (Eocene)
Tegq	GRANODIORITE AND QUARTZ DIORITE (Eocene)
Tq	QUARTZ DIORITE (Eocene or Paleocene)
TKlg	LEUCOCRATIC QUARTZ MONZONITE AND GRANODIORITE (Tertiary and/or Cretaceous)
TKgq	GRANODIORITE AND QUARTZ DIORITE (Tertiary and/or Cretaceous)
Kgq	BIOTITE-HORNBLENDE QUARTZ DIORITE, PLAGIOCLASE-PORPHYRITIC BIOTITE GRANODIORITE/QUARTZ DIORITE, BOTH LOCALLY CONTAIN GARNET AND/OR EPIDOTE (Cretaceous)
Ꞧt	TEXAS CREEK GRANODIORITE (Triassic)
MzPzmg	MIGMATITE AND ORTHOGNEISS, WITH LESSER PARAGNEISS (Mesozoic and/or Paleozoic)
MzPzpo	PARAGNEISS AND ORTHOGNEISS, WITH LESSER AMPHIBOLITE AND MARBLE (Mesozoic and/or Paleozoic)
MzPzsp	SCHIST AND PARAGNEISS, WITH LESSER AMPHIBOLITE AND MARBLE (Mesozoic and/or Paleozoic)
MzPzsv	METASEDIMENTARY AND LESSER METAVOLCANIC ROCKS, WITH LOCAL MARBLE (Mesozoic and/or Paleozoic)

Discussion

During U.S. Geological Survey investigations in the Bradfield Canal quadrangle between 1968 and 1979, 2784 rock geochemical samples, 1295 stream-sediment samples, and 219 stream-sediment heavy-mineral concentrate samples were collected. The samples were analyzed for up to 31 elements by a 6-step, semi-quantitative emission spectrographic method (Grimes and Marranzino, 1968) and for up to 5 elements by atomic-absorption techniques (Ward and others, 1969). Complete analytical data for all samples, plus location maps, station coordinates, and a discussion of sampling and analytical procedures are available in 3 reports (Koch and others, 1980a,b,c). These data are also available on magnetic computer tape (Koch, O'Leary, and Risoli, 1980).

Maps on this and the accompanying sheets show the amounts of copper (Cu) detected in all geochemical samples collected in the Bradfield Canal quadrangle. Copper analyses for most samples were done by both the 6-step spectrographic and the atomic-absorption methods. The spectrographic analytical values are reported as the approximate midpoints of geometrically spaced class intervals, with values in the series 1, 1.5, 2, 3, 5, 7, 10, 15, 20, ... (see Koch and others, 1980a,b,c, Grimes and Marranzino, 1968). Each of these reporting values is referred to as a "step" on the reporting scale. Analytical values from atomic-absorption analyses are reported at intervals of 5 ppm for values between 5 and 100 ppm, and at intervals of 10 ppm for values above 100 ppm.

Spectrographic and atomic-absorption analytical results for Cu are often somewhat different; though differences between corresponding values are distributed almost symmetrically about a difference of 0 steps. About 95 percent of the spectrographic values are between 2 steps lower and 3 steps higher than the corresponding atomic-absorption value for rock samples, 3 steps lower and 4 steps higher for stream-sediment samples, and 2 steps lower and 3 steps higher for heavy-mineral concentrates.

Atomic-absorption analyses have lower analytical determination limits and are considered to have greater precision than the spectrographic analyses (Richard M. O'Leary, pers. comm., 1980, Koch and others, 1980a,b,c, Motooka and Grimes, 1976). The nitric acid partial digestion used for atomic-absorption analyses dissolves sulfides and oxides, but only extracts metals from the surface of silicate grains. Thermal excitation during spectrographic analysis causes spectral emission from all Cu in the sample. An additional, nonsystematic source of discrepancy between the analyses may be sample inhomogeneity. Different fractions are used for the two analyses and only a small amount of sample, (0.01 g for rock and stream-sediment samples, 0.005 g for concentrate samples) is used for the spectrographic analyses.

Average geochemical abundances vary for different lithologies and in different areas. The degree of chemical weathering also affects the elemental abundances, although probably with minor effect in this recently glaciated terrain. Analytical variance and variations in sampling practice limit the repeatability of these results. Complex interactions between these sources of variation make it impossible to select a single threshold value which will discriminate between areas which are barren and areas with potentially valuable mineral concentrations.

In order to estimate which analytical values are sufficiently above general background levels to warrant further interest, the following procedure was followed for each sample type. Histograms of the data were examined for apparent breaks (discontinuities or abrupt changes in level) in the distribution. A cutoff value was selected at an arbitrarily chosen level near the 95th percentile or at a break close to that level when one was present. The geographic distribution of the samples above the cutoff level was examined for clumping and scatter. The cutoff level was adjusted up or down to minimize apparent geographic scatter ("noise").

Samples in which the Cu content was above the cutoff level are marked by one of three sizes of circles. Each circle size represents a range of analytical values, with larger circles indicating higher values. Samples in which the Cu content was below the cutoff level are indicated on the map by dots. The range, number, and percentage of values associated with each map symbol are indicated on the corresponding histogram. Higher values may indicate a greater likelihood of bedrock mineralization, but confidence levels are low for values near analytical limits of determinability, for single-element anomalies, for samples where atomic-absorption and spectrographic results are not both high, and for results not supported by high values in nearby samples.

Each rock sample was assigned to one of ten broad lithologic groups of similar rock types on the basis of the rock name given to the sample at the time that it was collected. The types of rocks included in each of the groups are summarized in the table labelled "Key to Lithology Group Symbols". On the map, circles representing rock samples with Cu content above the cutoff value are labelled with the letter indicating the lithology group for that sample.

Normal abundance[1/] of copper (in ppm) in the Earth's crust and various crustal components

		Ultramafic rocks	Basalt & gabbro	Andesites	Granitic rocks	Shale & clay	Limestone	Soil
Average[2/]	-	15	90	35	15	45	4	20
Range[2/]	-	-	30-160	-	5-30	18-120	-	2-100

	Earth's crust	Ultramafic rocks	Basalt	Granodiorite	Granite	Shale	Limestone	Soil
Average[3/]	55	10	100	30	10	50	15	2-100

1/ Note: Because the analyses on which these averages are based may not be directly compatible with the analyses used for this report, these figures serve only as a general guide.

2/ From Cox and others (1973)

3/ From Levinson (1974)

Copper is reported, usually as a secondary commodity, at many of the numerous prospects in the Banded Mountain, Texas Creek, and Salmon River areas at the southeastern corner of the Bradfield Canal quadrangle. Copper occurs in this area mainly in chalcopyrite, locally in tetrahedrite, and is usually associated with galena, pyrite, and sphalerite. Most of these deposits are within metasedimentary rocks, and consist of disseminated sulfides, sulfide veinlets and lenses, and sulfide-bearing quartz veins. A large skarn deposit along the North Bradfield River (Sonnevil, 1981) has been actively prospected for iron and copper for many years. Chalcopyrite, magnetite, and pyrrhotite occur in skarn float and chalcopyrite, pyrite, and magnetite occur as disseminated grains in metasedimentary rocks in the Craig River area along the Canadian border. Copper is reported at a number of prospects in unit MzPzsp close to, and just west of the quadrangle boundary near Berg Mountain, and Berg, Glacier, and Groundhog Basins. In that area, Cu is usually reported as a secondary commodity with lead, zinc, and sometimes silver and gold. These deposits consist mainly of massive and disseminated sulfides, and of metal-bearing quartz-carbonate veins. The only significant deposit near the Bradfield Canal quadrangle with Cu as the primary commodity is the Granduc Mine at the head of the Leduc River, just across the border in British Colombia. This mine has been a large-scale producer from massive and disseminated sulfides in metasediments for most of the past decade.

Atomic-absorption data for Cu in rock samples from the Bradfield Canal quadrangle shows values above the 100 ppm cutoff level scattered across the area, mainly in small groups within metamorphic rock units.

Atomic-Absorption Cu Values At and Above 100 ppm Cutoff Level

Lithology	Samples	Percent	Geometric Mean	Range
Metamorphic Rocks	70	55	150 ppm	100 - 2400 ppm
Mafic Meta. Rocks	18	14	155	100 - 400
Granitic Rocks	9	7	130	100 - 330
Skarn	10	8	1865	280 - 14000
Vein	4	3	160	110 - 420
Other	16	13	241	100 - 1400

For spectrographic Cu data for rock samples, some of the details are different but the data shows the same general distribution pattern of high values mainly in metamorphic rocks. Most of the major clusters of high values are in the same places as for the atomic-absorption data.

Spectrographic Cu Values At and Above 200 ppm Cutoff Level

Lithology	Samples	Percent	Geometric Mean	Range
Metamorphic rocks	49	50	270 ppm	200 - 1500 ppm
Mafic Meta. rocks	13	13	260	200 - 500
Granitic Rocks	6	6	350	200 - 1000
Skarn	10	10	2030	300 - 15000
Vein	8	8	770	200 - 3000
Other	13	13	360	200 - 1500

Data from both atomic-absorption and spectrographic analyses of stream-sediment samples also show concentration of high values in metamorphic units. In contrast to the rock data, only a few values above the cutoff levels occur in unit MzPzsp. Most of the highest values are concentrated in several areas of unit MzPzsv; near Mount Whipple, Craig River, Blue River, Banded Mountain, and the Salmon River.

For heavy-mineral concentrate samples, data from both analytical methods produce essentially the same pattern. Values above the cutoff levels occur almost entirely near metamorphic unit MzPzsv along the Canadian border.

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MAPS SHOWING DISTRIBUTION AND ABUNDANCE OF COPPER IN GEOCHEMICAL SAMPLES FROM THE BRADFIELD CANAL QUADRANGLE, SOUTHEASTERN ALASKA

by

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1981