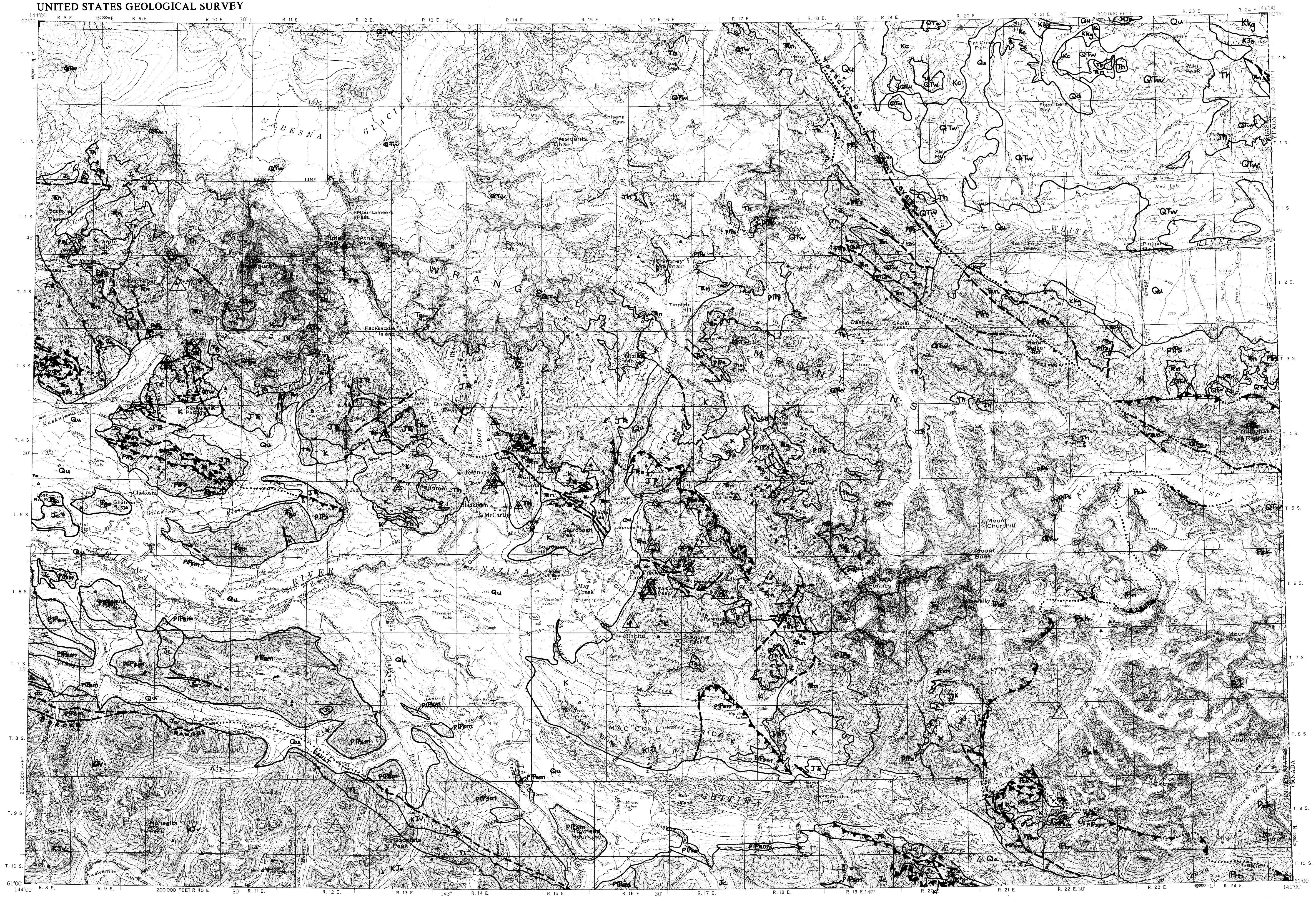
DEPARTMENT OF THE INTERIOR
UNITED STATES GEOLOGICAL SURVEY

MISCELLANEOUS FIELD STUDIES MAP MF-773-M
FOLIO OF THE McCARTHY QUADRANGLE, ALASKA



Base from U.S. Geological Survey, 1965
Geology generalized by MacKevett, 1976

Background information for this folio is published as U.S. Geological Survey Circular 739, available free of charge from the U.S. Geological Survey, Reston, Va. 22092.

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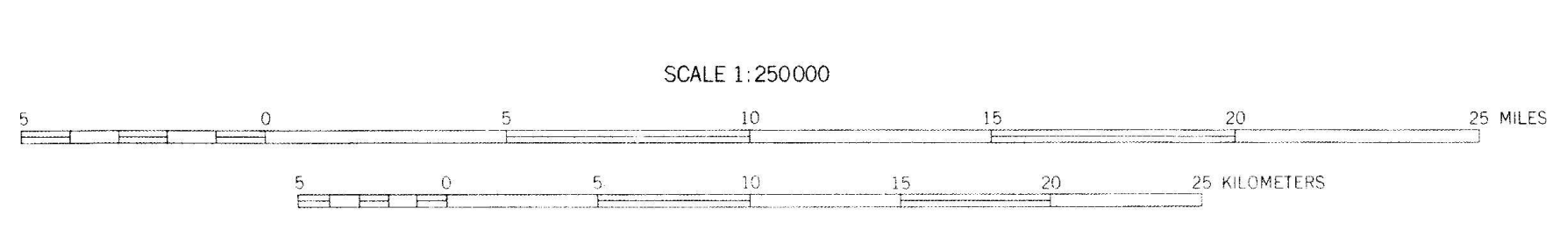

CONTOUR INTERVAL 200 FEET
DATUM IS MEAN SEA LEVEL
1960 MAGNETIC DECLINATION AT SOUTH EDGE OF SHEET VARIES FROM 28°30' TO 29° EAST

QUADRANGLE LOCATION

Table showing linear correlation coefficients between logarithmic values of the concentration of selected elements versus arsenic, McCarthy quadrangle, Alaska. [Leaders(---)indicate insufficient data.]

Analytical method	Six-step semiquantitative spectrographic analyses																										Atomic absorption and colorimetric [1]					
Element	Fe	Mg	Ca	Ti	Mn	Ag	As	B	Ba	Be	Bi	Co	Cr	Cu	La	Mo	Nb	Ni	Pb	Sb	Sc	Sr	V	Y	Zn	Zr	Au	Cu	Pb	Zn	Hg	As
Correlation Coefficient(X100)	44	20	12	31	30	8	▨	36	15	--	--	21	11	26	--	-49	12	45	34	3	7	-20	28	22	49	26	9	--	--	48	--	33
Number of pairs	63	65	58	64	67	35	▨	44	50	--	--	34	45	55	--	21	18	51	34	12	33	51	62	37	12	44	30	--	--	11	--	11

[1] Au, Cu, Pb, and Zn by atomic absorption analysis
Hg by flameless atomic absorption analysis
As by colorimetric analysis

DISTRIBUTION AND ABUNDANCE OF ARSENIC IN BEDROCK, MINERALIZED, VEIN, AND ALTERED ROCK SAMPLES, McCARTHY QUADRANGLE, ALASKA

By

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1976

DISCUSSION

A geochemical survey was conducted in the McCarthy quadrangle Alaska, to identify areas containing anomalous concentrations of various metallic nnd nonmetallic elements. This study incorporates the results of analyses for arsenic from 827 rock samples collected in the quadrangle and analyzed by the U.S. Geological Survey between 1961 and 1976 using semiquantitative emission spectrophotometry. The samples include both unaltered and hydrothermally altered rocks. The hydrothermally altered rock consist of ore grade material, gossans, fault gouge, vein materials, silica-rich boxworks, veins adjacent to faults, and fracture surfaces showing evidence of mineralization. Therefore, the analytical data set may be considered representative of most rock types known to occur in the study area.

The accompanying map shows the distribution and relative abundance of arsenic in rocks collected. Geochemical analyses have been grouped and are represented by symbols on a base map, which includes topography and generalized geology. The range of analytical values and the symbol that represents it are shown in the histogram. Graphical representation of analytical values on the map permits easy observation of any large variation resulting from separate or duplicate samples collected at the same or nearby localities. All samples were crushed and ground to pass through a 180 micron opening sieve before being analyzed.

The chemical analyses of unaltered and unmineralized bedrock samples are considered to represent background concentrations for the various rock units in the McCarthy quadrangle. These analyses were merged with those from samples representative of hydrothermally altered mineralized, and (or) biased rock types, such as ore grade material. Thus the geochemical distribution of arsenic analyses may help to locate potential occurrences of concealed mineral deposits, particularly large buried deposits such as porphyry copper or molybdenum.

The arithmetic and geometric mean values of arsenic in rocks from the McCarthy quadrangle are 1,399 and 750 ppm, respectively. Based on an evaluation of the statistical data given in the accompanying histogram, arsenic values ranging from N(200) to L(200) ppm are classified as background values. Those values between 200 and 500 ppm are classified as threshold to weakly anomalous, and values greater than 500 ppm arsenic are considered to be significantly anomalous.

Most of the arsenic detected in rocks collected in the McCarthy quadrangle seems to be associated with granitic intrusions, veins, and sulfide-rich rocks. The amygdaloidal basalt flows of the Middle and (or) Triassic Nikolai Greenstone do not appear to influence or be directly related to the presence of arsenic. This lack of association is evidence by the absence of statistically significant positive correlation coefficients occuring between arsenic, and component elements characteristic of the Nikolai Greenstone such as Fe, Mg, Ca, Ti, Mn, Ba, Co, Cr, Cu, Ni, Sr and V. Because of a limited number of samples, the very high spectrographic lower limit of detection for arsenic (200 ppm), and the many different rock types, only a few elements show significant positive correlation with arsenic. The significant positive correlation coefficients between arsenic and the elements iron, manganese, nickel, and vanadium, may be related to the occurrence of arsenopyrite or other sulfide minerals, or to magnetites and oxide minerals associated with sulfide mineralization, pegmatites, and granitic intrusions. The positive correlations between arsenic and titanium, and between arsenic and boron, may be related to the occurrence of titanium minerals and tourmaline in granite pegmatites and metamorphic rocks.

Because erratic, biased, and in many cases widely separated sample localities were used in this project, undue emphasis may be placed on anomalous arsenic values occurring in only one or two samples in a given area. In all cases, geochemical interpretation has been made utilizing associated elements in combination with geological, structural, and geophysical data. More detailed geological, analytical, and statistical data for geochemical studies of specific areas in the McCarthy quadrangle can be found in reports by MacKevett and Smith (1968), Winkler and MacKevett (1970), Knaebel (1970), and Winkler, MacKevett, and Smith (1971).

Because of its strong association with sulfide ores and gold, arsenic could be an important pathfinder element to use in the search for porphyry-type deposits. In addition, arsenic appears closely related to Kennecott-type copper deposits. Arsenic often forms halos around zoned porphyry copper deposits. The distributions of arsenic, molybdenum, silver, and gold in rocks, together with the distributions of copper, gold, lead, arsenic, and mercury in stream sediments and glacial debris, may reveal zoning patterns that are related to undiscovered mineral deposits.

Preliminary study of the geographic distributions of arsenic anomalies suggests that most of the arsenic is related to areas of potential Kennecott-type copper deposits, porphyry deposits, and mineralization in the Jurassic(?) and Cretaceous Valdez Group.

Of those rocks collected and analyzed from the area of the McCarthy quadrangle south of the Chitina River, only two contain anomalous concentrations of arsenic. The sparcity of anomalies however, as in other areas of the quadrangle, may be directly related to the high lower limit of detection of arsenic used in this spectrographic analysis. Colorimetric analyses with a lower limit of detection (10 ppm) show many anomalies for arsenic of stream sediments collected in the gold-producing rocks of the Valdez Group. The gold potential of this region is suggested by the association of anomalous concentrations of gold, silver, arsenic, lead, and mercury in samples of stream sediments and rocks collected in this general area.

Several strong arsenic anomalies were detected in rocks collected from the vicinity of Bonanza Ridge and Porphyry Mountain (T.5 S., R. 14 E.). In addition, both arsenic and mercury anomalies were detected in stream sediments from the west slope of Bonanza Ridge. Some weak arsenic and mercury anomalies were also detected in stream sediments collected from McCarthy and Nikolai Creeks and these observations suggest that arsenic and mercury may be associated with Kennecott-type copper deposits. Stream sediments from the area west of Bonanza Ridge, the area of Castle Peak (T. 3 S., R. 11 E.), and the area southeast of Bonanza Ridge in the Nikolai Butte area (T. 6 S., R. 17 E.), also have anomalously high arsenic and mercury concentrations. The Upper Triassic Chitistone Limestone crops out in these same areas and all Kennecott-type copper deposits are stratigraphically confined to the lower part of the Chitistone Limestone. Thus, arsenic and mercury, may be sensitive pathfinder elements for this type of low-temperature deposit, forming zoned halos around the deposits. More detailed studies should be conducted in these areas, using rock samples, to determine whether arsenic and mercury can be used to successfully predict and detect the occurence of concealed Kennecott-type copper deposits.

Only one arsenic anomaly was detected in rocks collected adjacent to the Totschunda fault system and to the northeast in the White River area (T. 1 S., R. 21 E.). However, very few samples from this area were analyzed and no conclusions can be drawn from the available data. More detailed sampling should be done.

Several arsenic anomalies were detected in rock samples from the general area of Barnard Glacier, south of the University Peak (T. 6 S., R. 20 E.). The arsenic anomalies seem related to a monzonitic-granitic complex of Pennsylvanian age that intrudes rocks of the Devonian(?) Kaskawulsh Group and the metamorphosed Pennsylvanian and Permian Skolai Group. Outcrops covering several square kilometers show evidence of strong hydrothermal alteration and positive aeromagnetic anomalies occur locally (Case and MacKevett, 1976). Anomalous amounts of copper, silver, gold, arsenic, mercury, and lead were detected in samples of stream sediments and rock collected in the same area. The intrusive complex also contains several molybdenum anomalies and two small tin anomalies. The presence of anomalies of all these elements suggests that this area might contain undiscovered porphyry-type copper and molybdeum deposits related to the intrusive complex.

Highly anomalous arsenic values were detected in rocks from the Dan Creek, Nikolai Butte, Williams Peak, Pyramid Peak, Andrus Peak, and Mount Holmes area (T. 6 S., R. 16 E.), and in the upper reaches of Canyon Creek, all located in the south-central part of the quadrangle. The anomalies are considered to be extremely significant. An intrusion of Tertiary granodiorite and tonalite, which forms small outcropping plutons, is inferred to underlie much of the area and is probably related to the Tertiary intrusive complex exposed in the University Range (T. 5 S., R. 18 E.) to the northeast. Anomalous concentrations of copper, silver, gold, mercury, antimony, lead, and molybdenum detected in samples of rock and stream sediment suggest that relatively intense mineralization probably occurs in this area. Strong positive magnetic anomalies are present (Case and MacKevett, 1976) and hydrothermally altered rocks are visible in outcrops. The area has been extensively placer mined for gold and is known to contain veins of gold-arsenic-antimony and gold-copper-molybdenum. These element associations suggest a strong possibility for concealed porphyry-type copper, molybdenum, or other types of deposits.

Very strong arsenic anomalies were detected in samples of rock collected from the general area of the Kuskulana River south of Skyscraper Peak (T. 2 S., R. 9 E.). The anomalies may be related to veins of sulfides in the Nikolai Greenstone. However, the close proximity of monzodiorite, granodiorite, and tonalite intrusives of the Jurassic Chitina Valley batholith suggests that the mineralized rocks may be related to the intrusives in the area (Moffit and Mertie, 1923). The arsenic anomalies are associated with copper, gold, silver, and molybdenum anomalies.

A few arsenic anomalies were detected in rocks collected south of Granite Peak (T. 1 S., R. 9 E.) and from the Kluvesna River. Anomalous concentrations of molybdenum, gold, copper, silver, arsenic, and mercury were also detected in some samples of stream sediment and rock collected in the same general locality. The Jurassic Chitina Valley batholith of monzodiorite, granodiorite, and tonalite underlies much of Granite Peak and intrudes the Nikolai Greenstone. Positive aeromagnetic highs occur locally (Case and MacKevett, 1976) and strongly altered rocks are visible in the area. Some geochemical anomalies may be related to veins of sulfide in the Nikolai Greenstone, however many of the anomalous samples may be related to undiscovered porphyry-type copper and possibly molybdenum deposits.

A complete set of coordinates for sample sites, as well as statistical and analytical data, obtained 1974-1976 for arsenic in rocks collected in the McCarthy quadrangle is available, together with details of sample collection, preparation, analysis, data storage and retrieval, in U.S. Geological Survey Open-File Report 76-824 (O'Leary and others, 1976) and on a computer tape (VanTrump and others, 1977).

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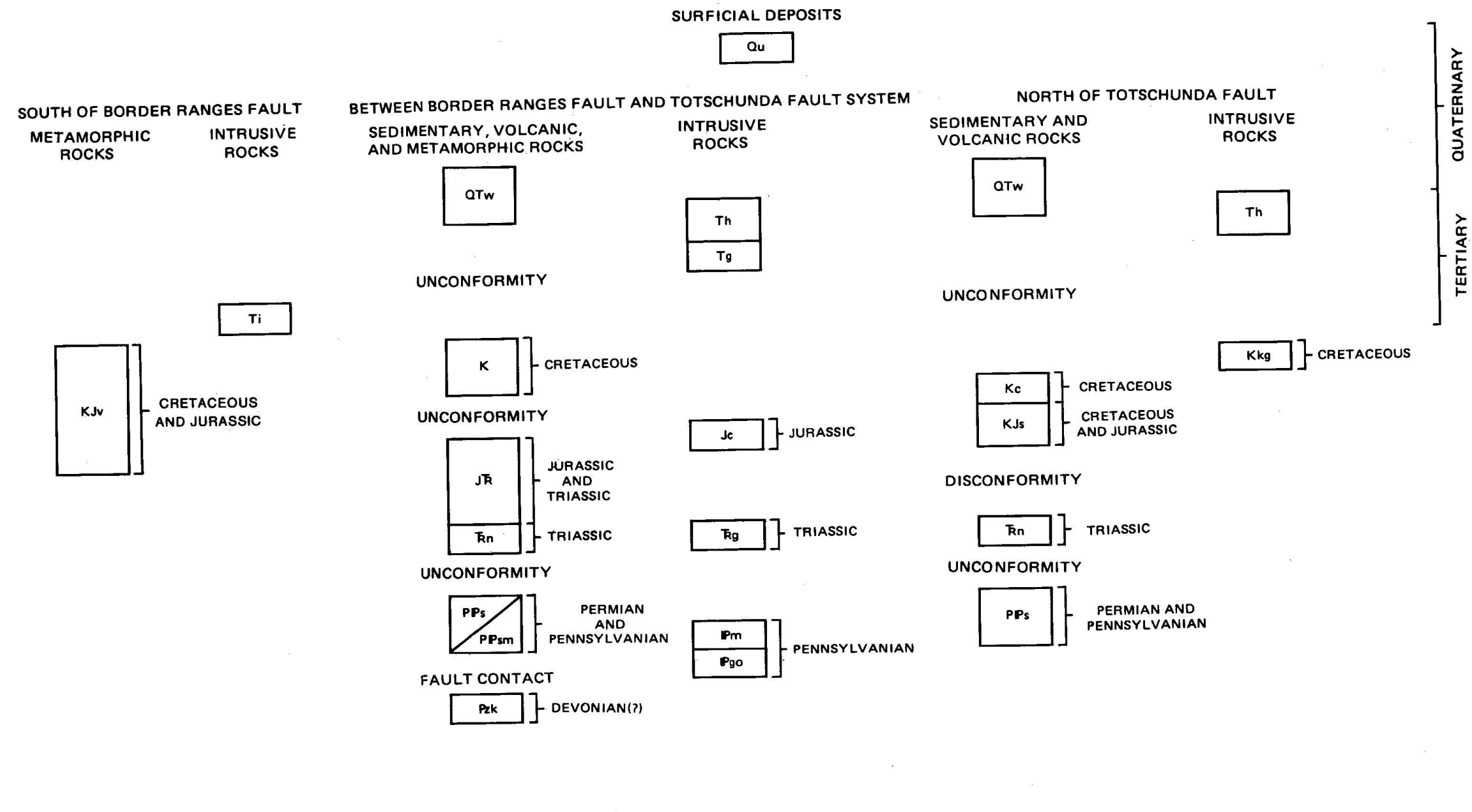
EXPLANATION FOR GENERALIZED GEOLOGIC MAP
(GEOLOGY GENERALIZED BY MacKEVETT, 1976)

CORRELATION OF MAP UNITS



DESCRIPTION OF MAP UNITS

SURFICIAL DEPOSITS

Qu	UNCONSOLIDATED SEDIMENTARY DEPOSITS (Quaternary)

SOUTH OF BORDER RANGES FAULT

METAMORPHIC ROCKS

KJv	VALDEZ GROUP (Cretaceous and Jurassic?)

INTRUSIVE ROCKS

Ti	INTRUSIVE ROCKS (Eocene?) Typically, foliated granodiorite and tonalite

BETWEEN BORDER RANGES FAULT AND TOTSCHUNDA FAULT SYSTEM

SEDIMENTARY, VOLCANIC, AND METAMORPHIC ROCKS

QTw	WRANGELL LAVA (Quaternary and Tertiary) Chiefly subaerial andesitic lava flows and tephra; includes local subaerial sedimentary rocks of the Frederika Formation
K	MARINE SEDIMENTARY ROCKS (Upper and Lower Cretaceous) Includes MacColl Ridge, Chititu, Moonshine Creek, Schulze, and Kennicott Formations, and unnamed Lower Cretaceous rocks
JTR	MARINE SEDIMENTARY ROCKS (Jurassic and Triassic) Includes Root Glacier, Nizina Mountain, Lubbe Creek, and McCarthy Formations, Kotsina Conglomerate, and Nizina and Chitistone Limestones
TRn	NIKOLAI GREENSTONE (Upper and (or) Middle Triassic) Mainly subaerial tholeiitic basalt; includes subordinate Chitistone Limestone north of Totschunda fault system
PIPs	SKOLAI GROUP (Permian and Pennsylvanian) As mapped includes a few scattered remnants of Middle Triassic sedimentary rocks in northeastern part of quadrangle
PIPsm	METAMORPHOSED SKOLAI GROUP (Permian and Pennsylvanian) Includes a few small outcrops of serpentinized ultramafic rocks near Border Ranges fault
Pzk	KASKAWULSH GROUP OF KINDLE (1953) (Devonian?)

INTRUSIVE ROCKS

Th	FELSIC HYPABYSSAL ROCKS (Pliocene) Mainly porphyritic dacite
Tg	GRANODIORITE (Pliocene) Unfoliated granodiorite with local mafic border facies
Jc	CHITINA VALLEY BATHOLITH (Jurassic) Mainly foliated quartz monzodiorite, granodiorite, and tonalite
TRg	GABBRO
IPm	MONZONITIC-GRANITIC COMPLEX (Pennsylvanian) Mainly nonfoliated quartz monzonite and granite, local mafic border facies
IPgo	GABBRO AND ORTHOGNEISS (Pennsylvanian)

NORTH OF TOTSCHUNDA FAULT SYSTEM

SEDIMENTARY AND VOLCANIC ROCKS

QTw	WRANGELL LAVA See above
Kc	CHISANA FORMATION (Lower Cretaceous) Marine and subaerial volcaniclastic and volcanic rocks
KJs	NUTZOTIN MOUNTAINS SEQUENCE (Lower Cretaceous and Upper Jurassic)
TRn	NIKOLAI GREENSTONE See above
PIPs	SKOLAI GROUP See above

INTRUSIVE ROCKS

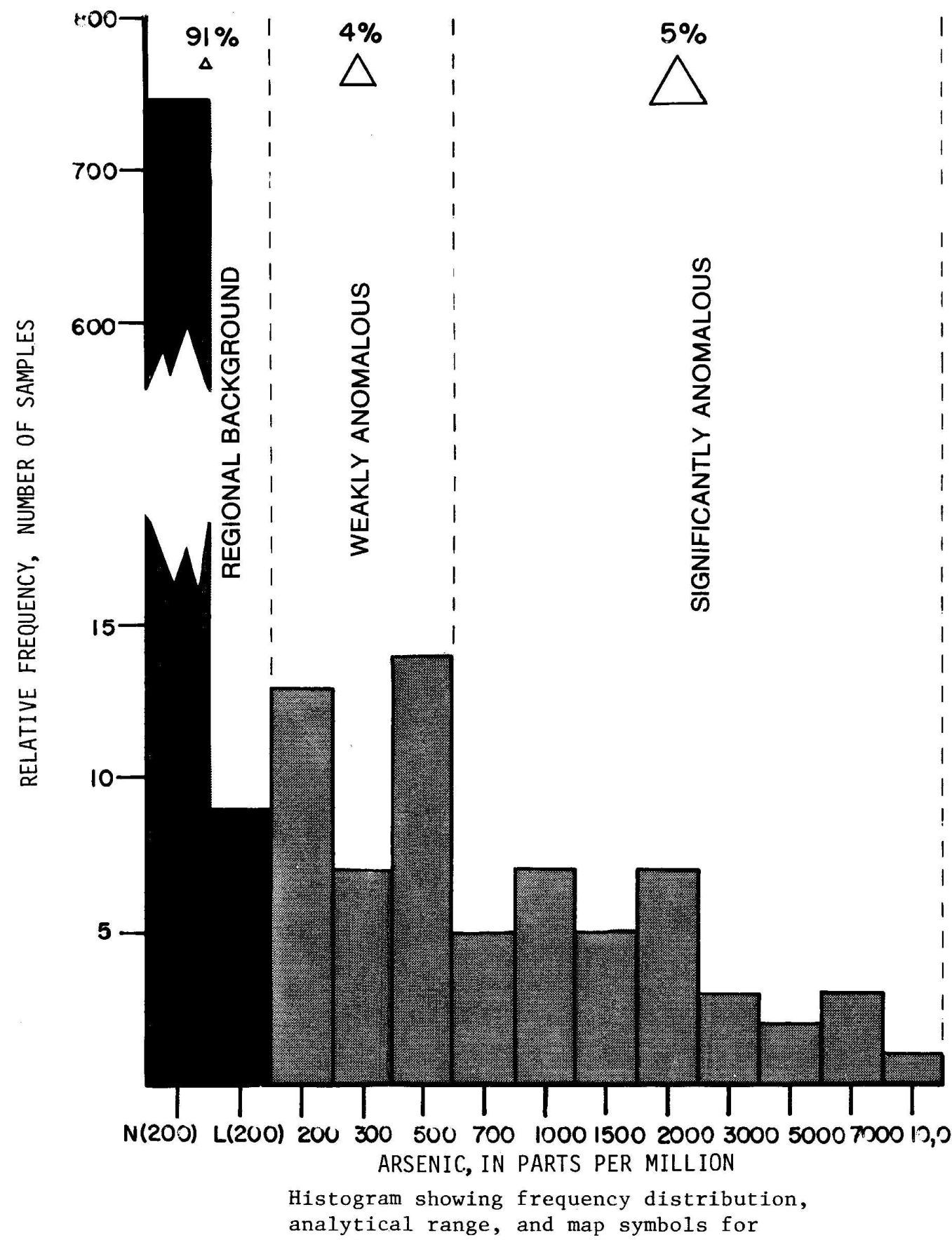
Th	FELSIC HYPABYSSAL ROCKS See above
Kkg	KLEIN CREEK PLUTON (Cretaceous) Chiefly granodiorite

Contact; dotted where concealed

High-angle fault; dotted where concealed

Thrust fault; sawteeth on upper plate. Dotted where concealed

NOTE: Areas without letter symbols are glaciers and snowfields



Histogram showing frequency distribution, analytical range, and map symbols for arsenic in samples of bedrock, mineralized rock, veins and altered rock, McCarthy quadrangle, Alaska.

MODE = N(200) ppm
MEDIAN = N(200) ppm

Calculation based on analysis of 827 samples with concentrations of As in the range N(200) through G(10,000) ppm

ARITHMETIC MEAN = 1399 ppm
STANDARD DEVIATION = 1932
GEOMETRIC MEAN = 750 ppm
GEOMETRIC DEVIATION = 2.9

Calculation based on analysis of 67 samples with concentrations of As in the range 200 through 10,000 ppm. Qualified N, L, and G values not included. N, not detected; but below limit of determination (200).

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