DEPARTMENT OF THE INTERIOR
UNITED STATES GEOLOGICAL SURVEY

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

SCALE 1:250000

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

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.

Table showing linear correlation coefficients between logarithmic values of the concentration of selected elements versus molybdenum, 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)	-26	-25	-23	-25	-7	0	-49	-14	-8	-1	--	2	-5	12	38	▨	23	-13	41	--	-8	7	-10	-17	33	-13	6	-31	-33	-6	-51	-19
Number of pairs	141	150	138	145	147	58	21	114	135	27	--	118	127	137	28	▨	63	138	53	--	116	120	149	116	14	133	44	17	17	19	13	12

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

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

By

Keith Robinson, C. M. McDougal, S. K. McDanal, and Theodore Billings

1976

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

DISCUSSION

A geochemical survey was conducted in the McCarthy quadrangle Alaska, to identify areas containing anomalous concentrations of various etallic and nometallic elements. This study incorporates the results of analyses for molybdenum from 825 rock samples collected in the quadrangle, and analyzed by the U.S. Geological Survey between 1961 and 1976 using semiquantitative emission spectrophotometry. The samples included both unaltered and hydrothermally altered rocks. The hydrothermally altered rock consists 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 molybdenum 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 on 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 molybdenum analyses may help to locate potential occurrences of concealed mineral deposits, particularly large buried deposits its such as porphyry copper or molybdenum.

The arithmetic and geometric mean values of molybdenum in rocks from the McCarthy quadrangle are 36 and 10 ppm, respectively. Based on an evaluation of the statistical data given in the accompanying histogram, molybdenum values ranging from N(5) to 5 ppm are classified as background values. Those values between 7 and 15 ppm are classified as threshold to weakly anomalous, and values greater than 15 ppm molybdenum are considered to be significantly anomalous.

Most of the molybdenum detected in rocks collected in the McCarthy quadrangle is vein associated or related to Tertiary granodiorite intrusives. The amygdaloidal basalt flows of the Middle and (or) Upper Triassic Nikolai Greenstone do not seem to influence or be directly related to the molybdenum mineralization. This lack of association is evidenced by the absence of statistically significant positive correlation coefficients occurring between molybdenum, 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 paired analyses and diverse rock types, only two elements analyzed by semiquantitative emission spectrophotometry, lead and possibly lanthanum, show significant positive correlation with molybdenum. The lack of significant, and in some cases strongly negative, correlation between molybdenum and other elements determined by spectrographic analysis is not unexpected. Spectrographic determinations for molybdenum were routinely made on all samples irrespective of whether they were mineralized or not. Many of these samples contain no detectable molybdenum but do contain many of the other metals, thereby resulting in a negative correlation between the two elements.

Because erratic, biased, and in many cases widely separated sample localities were used in this project, undue emphasis may be placed on anomalous molybdenum 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).

In addition to being a mineable commodity of considerable economic value, molybdenum is an important pathfinder element that can be used in the search for porphyry copper deposits. Molybdenum often forms halos associated with porphyry copper deposits. The distributions of molybdenum, gold, silver, and arsenic 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 distribution of molybdenum anomalies suggests that most of the molybdenum may be related to areas of potential porphyry deposits.

Relatively few rock samples have been collected in the area of the McCarthy quadrangle south of the Chitina River and analyzed for molybdenum. The only sample containing anomalous concentrations of molybdenum is from Golconda Creek area (T. 10 S., R. 11 E.) in the vicinity of the Yellowband and other gold mines. Other weakly anomalous molybdenum concentrations appear related to metamorphosed rocks of the Pennsylvanian and Permian Skolai Group.

Several significant molybdenum anomalies were detected in rocks collected from Porphyry Mountain (T. 5 S., R. 14 E.). These anomalies are probably related to Tertiary felsic hypabyssal rocks of mainly porphyritic dacite composition. Anomalous concentrations of gold, arsenic, and silver also detected in rocks from the Porphyry Mountain locality and the samples with silver anomalies seem to be zoned peripherally to those containing molybdenum and gold anomalies. Stream sediments collected in the general vicinity contain anomalous concentrations of copper, arsenic, and mercury. In addition, an aeromagnetic survey suggests the presence of positive anomalies (Case and MacKevett, 1976). While the area is not presently known to contain economic mineralization, the potential for porphyry copper and molybdenum deposits should be considered.

Only two molybdenum anomalies were detected in rock samples collected adjacent to the Totschunda fault system (T. 3 S., R. 21 E.) and these seem to be fault related. However, very few samples from this and the White River area to the northeast, have been analyzed and no conclusions can be drawn from the available data. More detailed sampling is required.

Two molybdenum anomalies were detected in rock samples from the general area of the Hawkins Glacier, south of the University Peak (T. 6 S., R. 20 E.). The molybdenum anomalies are probably related to a monzonite-granitic complex of Pennslyvanian age that intrudes rocks of the metamorphose 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 gold, copper, arsenic, mercury, and lead were detected in samples of stream sediments and rock collected in the same area. The intrusive complex also contains two small tin anomalies. The presence of anomalies of all these elements suggests that this area might contain undiscovered porphyry-type copper and molybdenum deposits related to the intrusive complex.

Several strong molybdenum anomalies were detected in rocks from an area intruded by Tertiary granodiorite and tonalite in the vicinity of The TWA Harpies (T. 6 S., R. 19 E.). Anomalous molybdenum concentrations in rock samples collected in the vicinity of the TWA Harpies Glacier valley (T. 5 S., R. 18 E.), may also reflect mineralization related to the exposed Tertiary granodiorite and tonalite. Zones of intense hydrothermal alteration are visible in the outcrop. The intrusive may be inferred to extend northwest under the central part of the University Range, which is supported by aeromagnetic data (Case and MacKevett, 1976). Anomalous concentrations of copper, arsenic, molybdenum, mercury, silver, and gold are also present in samples of rocks and stream sediments collected in the same general locality and this area may contain porphyry-type copper or molybdenum deposits.

Highly anomalous molybdenum 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 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. These intrusives are 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, arsenic, 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 strongly suggest the possibility of concealed porphyry-type copper, molybdenum, or other types of deposits.

Very strong molybdenum 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 suggest that the mineralized rocks may be related to the intrusives in the area (Moffit and Mertie, 1923). The molybdenum anomalies are associated with copper, arsenic, silver, and gold anomalies.

A few molybdenum anomalies were detected in rocks collected south of Granite Peak (T. 1 S., R. 9 E.) and in the Kotsina River valley. Anomalous concentrations of gold, copper, 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.

Molybdenum anomalies detected in rock samples south of the Kuskulana River (T. 3 S., R. 9 E.) suggest the possibility of mineralization in a skarn environment. Anomalous concentrations of copper, silver, arsenic, and gold were detected in samples of rock and stream sediment collected in this area.

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

REFERENCES

Knaebel, Jeff, 1970, Geochemical survey and geological reconnaissance of the White River area, south-central Alaska: Alaska Div. Mines and Geology, Geochem. Rept. 21, 60 p.

Case, J. E., and MacKevett, E. M., Jr., 1976, Aeromagnetic map and geologic interpretation of aeromagnetic map, McCarthy quadrangle, Alaska: U.S. Geol. Survey Misc. Field Studies Map MF-773-D.

MacKevett, E. M., Jr., and Smith, J. G., 1968, Distribution of gold, copper, and some other metals in the McCarthy, B-4 and B-5 quadrangles, Alaska: U.S. Geol. Survey Circ. 604, 25 p.

Moffit, F. H., and Mertie, J. B., Jr., 1923, The Kotsina-Kuskulana district, Alaska: U.S. Geol. Survey Bull. 745, 149 p.

O'Leary, R. M., McDanal, S. K., Day, G. W., McDougal, C. M., and Robinson, Keith, 1976, Spectrographic and chemical analyses of geochemical samples from the McCarthy quadrangle, Alaska: U.S. Geol. Survey Open-File Rept. 76-824, 806 p. Available only at USGS libraries in Reston, Va., Denver, Co., and Menlo Park, Ca., and USGS Public Inquiries Office, Anchorage, Ak.

Richter, D. H., Albert, N. R. D., Barnes, D. F., Griscom, Andrew, Marsh, S. P., and Singer, D. A., 1975, The Alaskan mineral resource assessment program; background information to accompany folio of geologic and mineral resource maps of the Nabesna quadrangle, Alaska: U.S. Geol. Survey Circ. 718, 11 p.

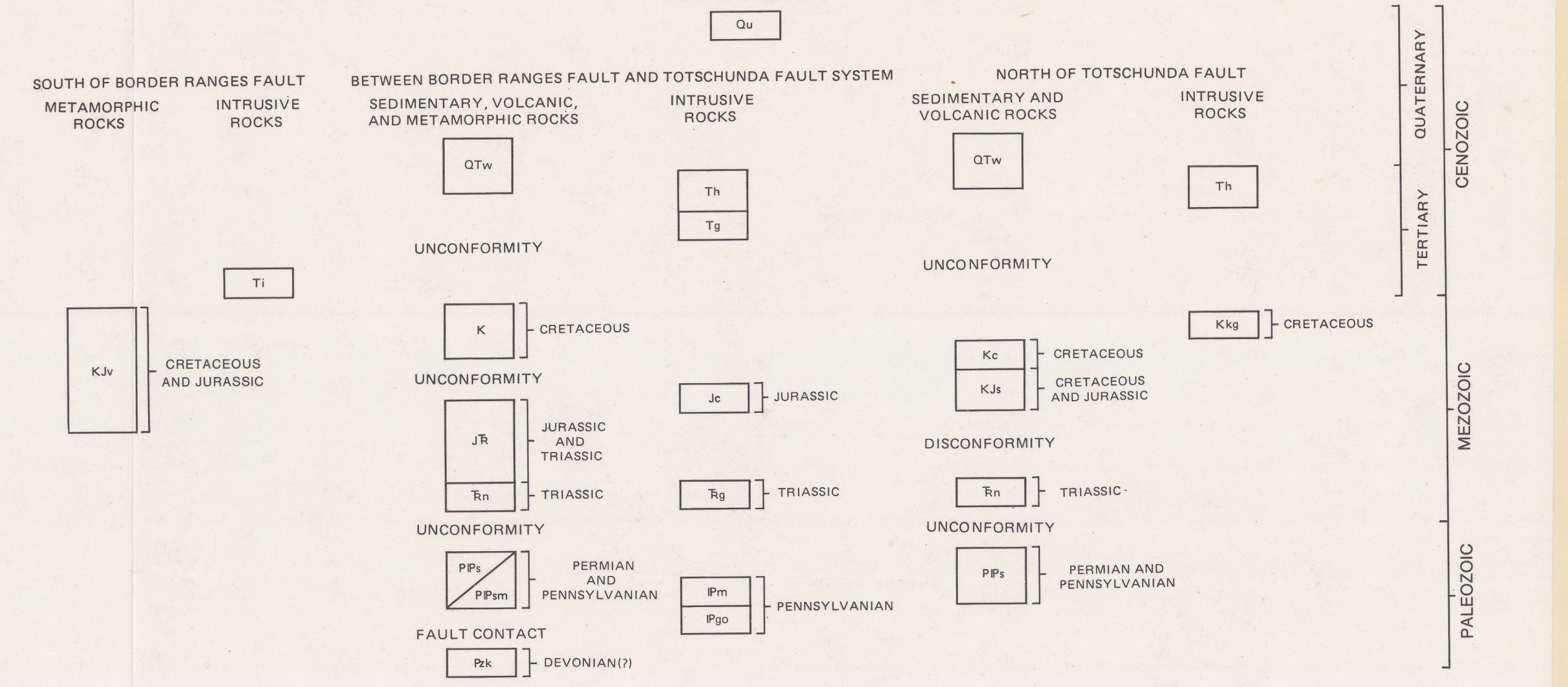
VanTrump, George, Robinson, Keith, O'Leary, R. M., Day, G. W., and McDougal, C. M., 1977, Spectrographic and chemical analyses of geochemical samples from the McCarthy quadrangle, Alaska: Available only from U.S. Dept. Commerce Natl. Tech. Inf. Service, Springfield, Va. 22161, in press.

Winkler, G. R., and MacKevett, E. M., Jr., 1970, Analyses of stream sediment samples from the McCarthy C-8 quadrangle, southern Wrangell Mountains, Alaska: U.S. Geol. Survey Open-file report, 45 p.

Winkler, G. R., MacKevett, E. M., Jr., and Smith, J. G., 1971, Geochemical reconnaissance of the McCarthy B-6 quadrangle, Alaska: U.S. Geol Survey Open-file report, 8 p.

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

CORRELATION OF MAP UNITS

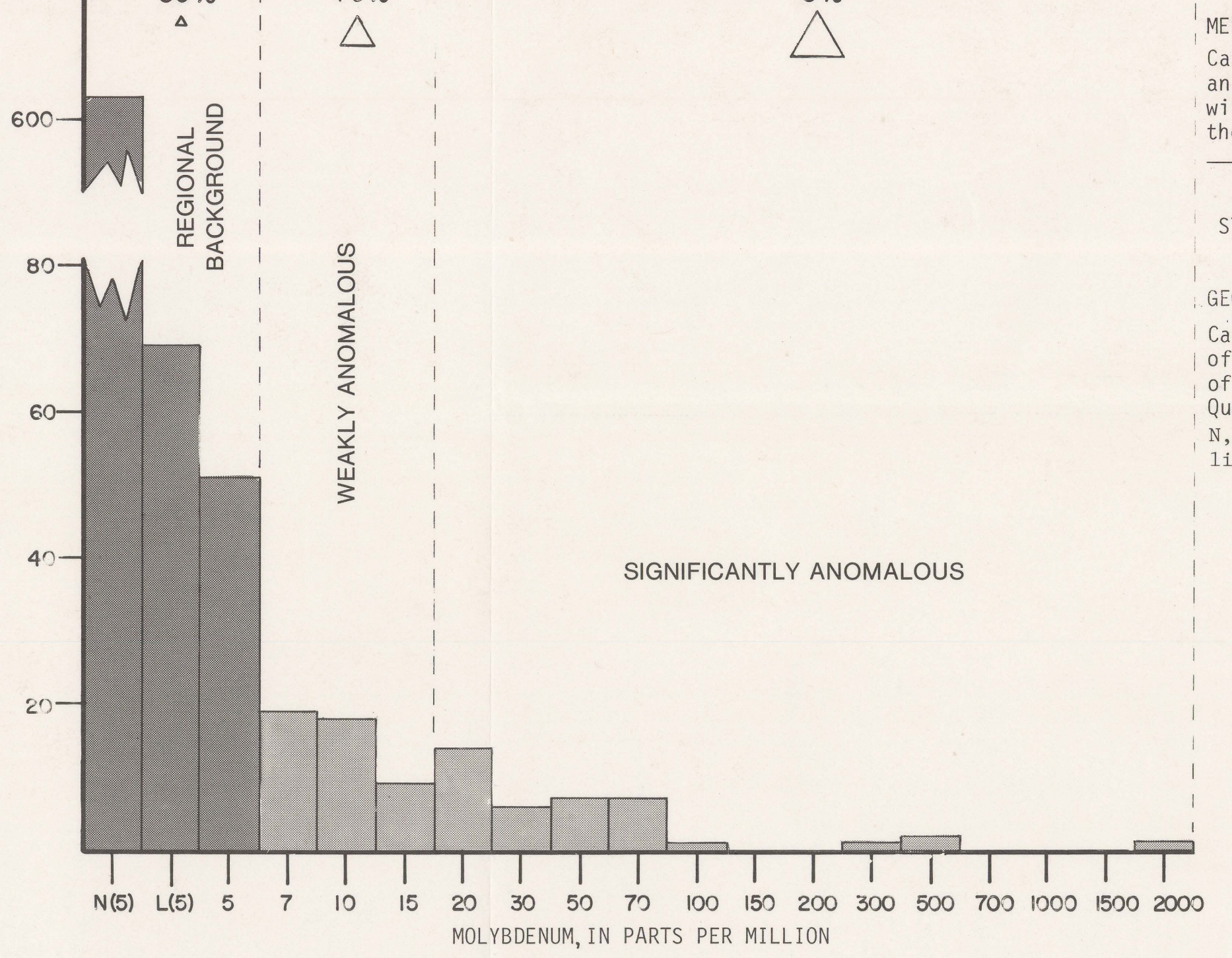


DESCRIPTION OF MAP UNITS

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



MODE = N(5) ppm
MEDIAN = N(5) ppm
Calculation based on analysis of 825 samples with concentrations of Mo in the range N(5) through G(2000) ppm

ARITHMETIC MEAN = 36 ppm
STANDARD DEVIATION = 173
GEOMETRIC MEAN = 10 ppm
GEOMETRIC DEVIATION = 3
Calculation based on analysis of 150 samples with concentrations of Mo in the range 5 through 2000 ppm. Qualified N, L, and G values not included.
N, not detected; L, detected but below limit of determination (5).

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

INTERIOR—GEOLOGICAL SURVEY, RESTON, VIRGINIA—1976

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~~Alaska (Mc Carthy quad.). Molybdenum. 1:250,000 1976~~
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