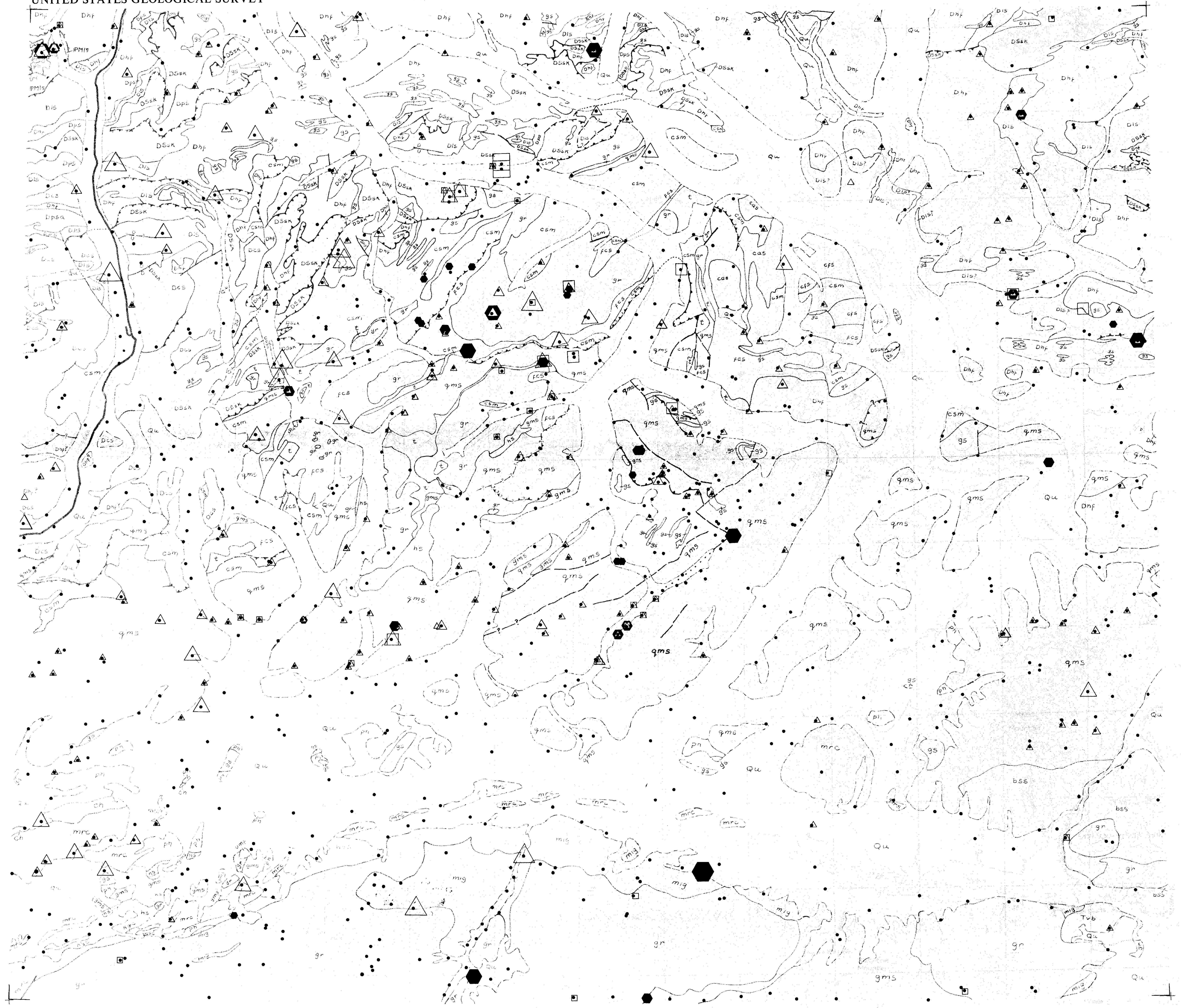
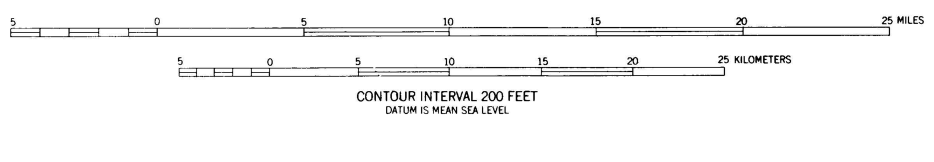
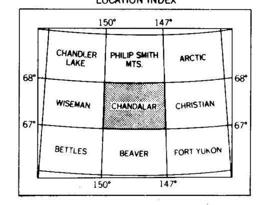
DEPARTMENT OF THE INTERIOR
UNITED STATES GEOLOGICAL SURVEY

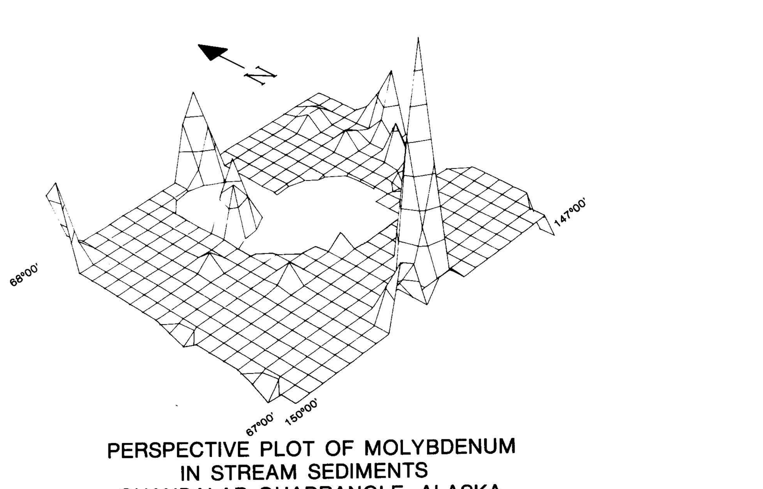


Base from U.S. Geological Survey, 1956

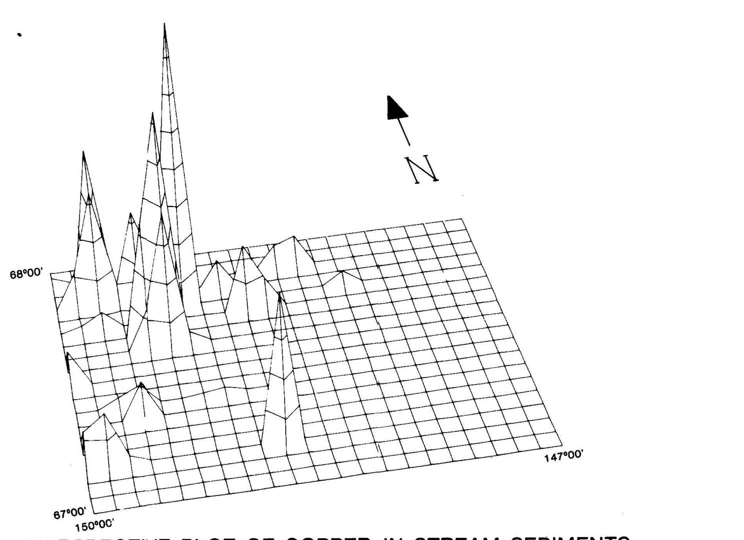
Data compiled, 1975-77



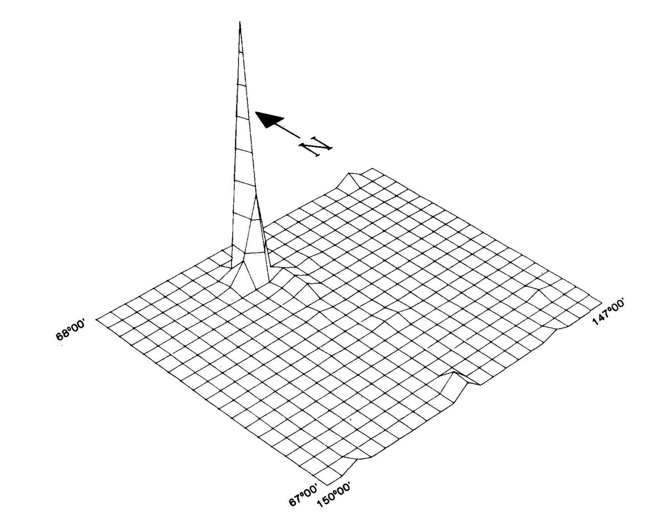




PERSPECTIVE PLOT OF MOLYBDENUM IN STREAM SEDIMENTS CHANDALAR QUADRANGLE, ALASKA



PERSPECTIVE PLOT OF COPPER IN STREAM SEDIMENTS CHANDALAR QUADRANGLE, ALASKA



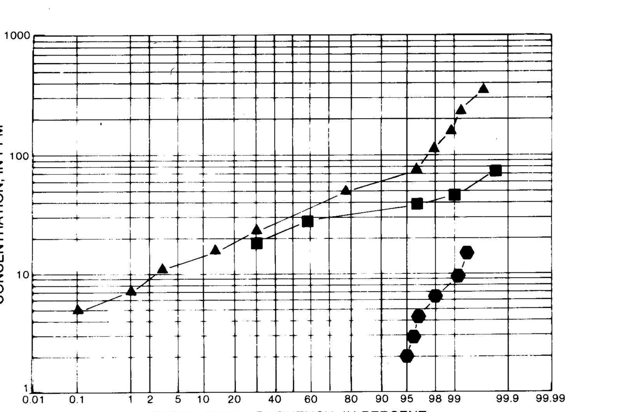
PERSPECTIVE PLOT OF LEAD IN STREAM SEDIMENTS CHANDALAR QUADRANGLE, ALASKA

CORRELATION COEFFICIENT

		B	BA	CO	CU	LA	MO	NB	NI	PB	V	Y	ZN	SB	AS
		Six-step semiquantitative spectrographic analysis											Atomic absorption analysis		Colorimetric analysis
Six-step semiquantitative spectrographic analysis	B		-.05	.24	.21	.04	.07	-.11	.26	-.02	.14	.09	.40	.17	-.06
	BA	962		.29	.12	.11	-.30	.17	.06	.27	.51	.14	.25	.08	.21
	CO	897	909		.27	.08	.07	.07	.51	.22	.35	.22	.42	.09	-.17
	CU	962	975	909		.12	.29	.01	.47	.31	.27	.14	.35	.20	-.08
	LA	750	759	716	759		.20	.16	.10	.22	.14	.40	.05	-.04	-.02
	MO	44	45	37	39	39		-.38	.43	.003	.25	.34	.25	.22	.04
	NB	411	417	416	416	414	14		.01	.13	.19	.36	-.19	-.01	.28
	NI	963	976	909	977	760	41	418		.23	.40	.29	.43	.20	-.23
	PB	889	900	872	902	707	41	412	902		.19	.27	.24	.15	.20
	V	963	976	909	977	760	46	417	978	902		.32	.24	.11	-.05
	Y	921	932	881	932	731	41	413	933	873	933		.002	-.03	-.10
Atomic absorption analysis	ZN	950	963	897	964	752	46	413	965	890	965	929		.36	.01
	SB	797	808	805	807	631	29	389	808	802	808	792	801		.14
Color. anal.	AS	229	229	171	231	161	21	27	231	183	231	198	228	112	

NUMBER OF SAMPLE PAIRS

CORRELATION DIAGRAM FOR MOLYBDENUM, COPPER, AND LEAD IN STREAM SEDIMENTS CHANDALAR QUADRANGLE, ALASKA



CUMULATIVE FREQUENCY PLOT FOR MOLYBDENUM (●), COPPER (▲), AND LEAD (■) IN STREAM SEDIMENTS CHANDALAR QUADRANGLE, ALASKA

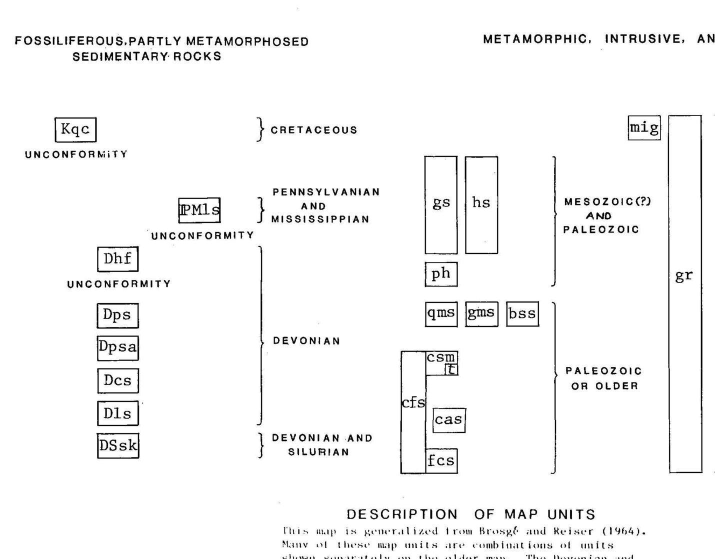
GEOCHEMICAL AND GENERALIZED GEOLOGIC MAP SHOWING DISTRIBUTION AND ABUNDANCE OF MOLYBDENUM, COPPER, AND LEAD IN STREAM SEDIMENTS IN THE CHANDALAR QUADRANGLE, ALASKA

By
S. P. Marsh, D. E. Detra, and S. C. Smith
1978

EXPLANATION

GEOLOGY GENERALIZED AND REVISED FROM BROSGE AND REISER, 1964, AND CHIPP, 1970

CORRELATION OF MAP UNITS



DESCRIPTION OF MAP UNITS

This map is generalized from Brosgé and Reiser (1964). Many of these map units are combinations of units shown separately on the older map. The Devonian and Devonian(?) age that was assigned to the metamorphic rocks by Brosgé and Reiser (1964) is herein revised to early Paleozoic or older.

SURFICIAL DEPOSITS

Qu	Unconsolidated sedimentary deposits (Quaternary)

FOSSILIFEROUS PARTLY METAMORPHOSED SEDIMENTARY ROCKS

Kqc	Quartz pebble conglomerate (Cretaceous)
PMls	Lisburne Group (Pennsylvanian and Mississippian) and Kayak Shale (Mississippian)--Limestone, dolomite, shale and conglomerate
Dhf	Hunt Fork Shale (Upper Devonian)--Slate and phyllite
Dps	Purple and green slate and phyllite (Devonian)
Dpsa	Purple and green andesitic volcanic sheared conglomerate (Devonian)
Dcs	Chloritic siltstone and grit (Devonian)--Schistose; in part graywacke
Dls	Limestone and siltstone (Upper Devonian)--Schistose; includes some green slate locally
DSsk	Skajit Limestone (Upper and Middle Devonian, Upper Silurian)--Limestone, dolomite, and marble

METAMORPHIC, INTRUSIVE AND VOLCANIC ROCKS

Tvb	Vesicular olivine basalt flows (Tertiary?)
mig	Migmatite--Intercalated mica schist and granite; granite with mafic inclusions
gr	Granitic rocks--K/Ar dates of biotite are 101 m.y. and 125 m.y. (Brosgé and Reiser, 1964); of hornblende, 486 m.y. (M. L. Silberman and D. L. Turner, written commun., 1977)
mrc, ch	Mafic rocks and chert--Pillow basalt, andesite, minor chert; diorite; diabase and gabbro. Chert (ch) differentiated where abundant
umf	Ultramafic rocks
gs	Greenstone and greenschist--Includes pillowed flows in Hunt Fork Shale (Dhf) in northeast part of the quadrangle
hs	Hornblende schist--Mostly hornfels facies
ph	Phyllite and schistose wacke
qms	Quartz muscovite schist
gms	Garnet mica schist--Mostly hornfels facies
bss	Biotite staurolite schist--Hornfels facies
csm, t	Calcareous schist, marble and tactite (t) locally
cfs	Undifferentiated calcareous schist (csm) and feldspathic chloritic schist (fcs)
fcs	Feldspathic chloritic schist--Includes metadiorite sills and pyritic quartzite
cas	Chloritized amphibole schist--Local remnant glaucophane

GEOLOGIC SYMBOLS

CONTACT--Dashed where approximate; dotted where concealed

NORMAL FAULT--Dashed where inferred, queried where doubtful; dotted where concealed; U, upthrown side; D, downthrown side

THRUST FAULT--Queried where doubtful; dotted where concealed. Sawteeth on upper plate

GEOCHEMICAL SYMBOLS

- Sample localities
- Anomalous values of molybdenum
- Anomalous values of copper
- Anomalous values of lead

DISCUSSION

This geochemical map shows the distribution and abundance of molybdenum (Mo), copper (Cu), and lead (Pb) of -80 mesh (177 micrometers) stream sediment samples in the Chandalar quadrangle, Alaska. The map is part of a series of geochemical maps that together with the background information circular (Reiser and others, 1978) comprise the folio on the Chandalar quadrangle, Alaska. The data are plotted on a subdued base map showing the generalized geology, topography, and sample localities. Map symbols showing the ranges of metal values are indicated on the accompanying histograms and all values shown are considered anomalous. An explanation of sampling, preparation, analytical procedures and geochemical raw data for all samples are discussed by O'Leary and others (1976). The -80 mesh (177 micrometers) stream sediment medium was used in this study because of the regional setting in the north-central Brooks Range. Given the rather restrictive time and manpower constraints the -80 mesh (177 micrometers) stream sediment combined with panned concentrates was determined to be the most economical and adequate medium in this case where clastic sediments are probably derived from local bedrock.

The study area is one of generally high relief with short fast-moving streams and broad glacial valleys. All samples were taken from active streams, as close to the center channel as possible. All sediments were considered to be locally derived. Care was taken, when sampling an obviously glaciated terrane, to sample above or upstream from morainal material, wherever possible. Most samples were taken in areas where bedrock was within 30 m of the sample site.

GEOCHEMISTRY OF MOLYBDENUM, COPPER, AND LEAD

Molybdenum is an oxyphile element and is concentrated in the last stages of magmatic crystallization, often in granites in the form of molybdenite (MoS_2) (Rankama and Sahama, 1955). Because it has a high affinity for sulfur it will form molybdenite whenever sulfur is available during crystallization. Molybdenum minerals weather readily to form soluble molybdates (Rankama and Sahama, 1955). In the Chandalar quadrangle the pH of the streams is rather low (4.5-5.5) and Mo is not transported far as soluble molybdates.

Copper is a relatively abundant chalcophile element that, like Mo, crystallizes in the last stages of magmatic crystallization; Cu however forms more complex sulfides than Mo (Rankama and Sahama, 1955). Copper will combine with any available sulfur during crystallization. Copper minerals weather readily to water soluble sulfates and with the low pH of the streams in the Chandalar quadrangle, copper is not precipitated in the stream sediments.

Lead has a high affinity for sulfur at low temperatures and crystallizes late in hydrothermal solutions to form the sulfide galena. Galena oxidizes readily into lead sulfate, but, because the sulfate is not highly soluble, it does not migrate far (Rankama and Sahama, 1955). In the Chandalar quadrangle, lead anomalies are probably very locally derived.

STATISTICAL DATA

There are four sections of statistical data included with this map: 1) Three histograms show frequency (number of samples) plotted against concentration in ppm (parts per million). Analytical values qualified by an N indicate that an element was not detected at an established lower limit of detection (5 ppm for Mo, 5 ppm for Cu, and 10 ppm for Pb) Analytical values, qualified by an L, indicate that the element was detected, but at a concentration below the lower limit of determination. A short table of statistical information is included with each histogram. 2) A correlation diagram shows correlation coefficients in decimal fraction of 1 in the upper part and the number of sample pairs used in the correlation in the lower part. The correlation coefficients and number of sample pairs for molybdenum, copper, and lead are shaded on the diagram. A coefficient of 1 indicates a perfect direct proportional relation, -1 an inverse relation. 3) A cumulative frequency plot shows cumulative frequency plotted against concentration of Mo, Cu, and Pb in ppm. 4) Three perspective plots, show a three-dimensional representation of anomalous Mo, Cu, and Pb in the Chandalar quadrangle. A grid was arbitrarily applied to the quadrangle to give the best representation of Mo, Cu, and Pb. The metal values of samples in each grid were averaged. The peaks shown reflect this average. The plateaus in the molybdenum perspective plot represents the 5 ppm detection limit and the large void in the center of the plot represents an area of older data that were not analysed. The plateaus in the other perspective plots represent an arbitrary anomalous value (shown on the histograms as a line pattern), usually the 95th percentile or two standard deviations from the norm. Because N and L values were used only in the histograms and cumulative plots and not in the computation of other statistical information, the results may be somewhat biased; for example in the case of molybdenum, all samples with a reported value were in the 95th percentile and considered anomalous.

OCCURRENCES

Molybdenum

The most significant occurrence of molybdenum, with associated copper and lead, in the Chandalar quadrangle is in the north-central area, at the headwaters of Geroe Creek. Geologically the area is one of metamorphosed granitic rocks (gr) surrounded by feldspathic chloritic schist (fcs) and calcareous schist, marble (csm), and tactite (t). In the zone of highest molybdenum values the granitic rocks have been altered to quartz-sericite schist with concentrations of pyrite and molybdenite. The altered zone is iron stained, and otherwise discolored, and visible from the air from many kilometers. Relief in the area is from 150 to 250 m and the altered zone extends over several square kilometers. Rock samples were taken from the central part of the altered zone and analyses for copper, molybdenum, lead, and tin are shown in table 1 as well as analyses for tellurium and gold. High concentrations of molybdenum in the altered zone and the observance of secondary copper mineralization in the field combine with a somewhat irregular geochemical halo of copper anomalies around the altered zone to indicate the possibility that this area may be the central core of a porphyry copper-molybdenum system. A weak zone of lead and zinc anomalies surrounds the molybdenum-copper zone, especially to the east. Weak anomalies of nickel, cobalt and lanthanum (Marsh and others, 1978a, b) extend south and east from the altered zone.

Sample No.	Semiquantitative spectrographic analyses in ppm				Atomic absorption analyses in ppb	
	Mo	Cu	Pb	Sn	Te	Au
CH272R	N	300	30	N	35.0	2.0
CH272RA	N	30	30	N	6.0	0.9
CH273R	70	30	70	N	90.0	0.8
CH274R	700	5	10	N	11.0	4.6
CH275R	N	10	10	N	7.0	1.0
CH276R	N	7	10	N	30.0	1.8
CH277RA	N	L	10	150	22.0	1.4
CH277RB	700	7	15	30	28.0	1.2
CH279R	20	30	500	N	190.0	11.0

Table 1.--Semiquantitative spectrographic and atomic absorption analyses of rock samples from the Geroe Creek altered zone, Chandalar quadrangle, Alaska

[Spectrographic analyses by G. W. Day. Concentration in parts per million (ppm). Atomic absorption analyses by J. Waterson. Concentration in parts per billion (ppb) N, not detected; L, detected, but below limit of determination]

Another, small area, of anomalous molybdenum occurs in quartz-muscovite-schist (qms) in the south-central part of the quadrangle along Big Creek and its tributaries. This area is associated with an aeromagnetic high and may represent buried, mineralized intrusive rocks (Cady, 1978). Copper, weak lead, zinc, cobalt, lanthanum, and boron anomalies are also associated with this area (Marsh and others, 1978a, b, c).

The anomalous area in the northwest corner of the map is underlain by black shales of the Hunt Fork Shale (Dhf) and older phyllites (ph). Anomalies occur in practically all elements in stream sediment samples, however, rock samples taken from the area (table 2) were not anomalous

Sample No.	Element Cu	Mo	Pb
CH032RA	30	N	20
CH032RB	30	N	15
CH032RC	50	N	30

Table 2.--Semiquantitative spectrographic analysis of rock samples from the Hunt Fork Shale, Chandalar quadrangle, Alaska

in any elements; this would indicate that the source of the anomalies is off the map to the west, possibly from a massive sulfide type of deposit.

The scattered molybdenum anomalies along the southern border of the quadrangle are in granitic rocks (gr) and probably represent small scattered quartz-molybdenite veins. Significantly more occurrences of molybdenum with tin were noted in the nonmagnetic fractions of panned concentrate samples from the granitic rocks suggesting that small molybdenum veins may be wide-spread in this area (Detra and others, 1977). Several copper and two small molybdenum and lead anomalies in the central southwest area of the map near the O'Keefe Hills in quartz-muscovite schist (qms) are associated with much stronger molybdenum, copper, lead, and tin anomalies in nonmagnetic panned concentrate fractions from the area (Detra and others, 1977). This association may represent a continuation of mineralization along strike from the Geroe Creek area; there is a possibility of concealed mineralized intrusives in the area.

A scattering of anomalous values along the northeast edge of the quad corresponds with weak copper, zinc, boron, and lanthanum anomalies (Marsh and others, 1978a, b, c). A broad weak aeromagnetic high is exhibited in this area and may reflect mineralization from a deeply buried pluton (Cady, 1978).

Copper

Copper is more widespread in the quadrangle than either molybdenum or lead; most anomalies occur in the northern half. The most significant copper occurrence in the quadrangle is a skarn type deposit along the southern end of Big Spruce Creek. Numerous outcrops containing copper occur in Skajit Limestone (DSsk), tactite (t) and calcareous schist and marble (csm) in this area; a detailed study is given by Marsh and Wiltse (1978) in this folio. From this skarn zone, the copper anomalies continue to the northeast in similar rocks, terminating on the south side of the North Fork of the Chandalar River.

An area weakly anomalous in copper occurs in the Geroe Creek altered zone, within the area of anomalous molybdenum. Copper and molybdenum have a relatively high correlation coefficient (0.29) and would be expected to occur together. Crude zoning is suggested by a stronger copper anomaly which occurs to the east of the Geroe Creek altered zone.

Another area of relatively high copper anomalies occurs roughly parallel to and northwest of the anomaly in Big Spruce Creek. This anomaly is apparently not confined to any one geologic unit, although it parallels the regional strike. It may represent mineralization along a concealed structural feature.

Four other areas on the map contain anomalous copper: 1) Copper anomalies occur in the northwest corner of the map and are probably related to the Hunt Fork Shale (Dhf) or older black phyllites and are derived updrainage, off the map to the west. 2) An area of copper anomalies occurs south of Chekhechunnjik Creek on the east edge of the quadrangle and is associated with arsenic, molybdenum, silver, and antimony in the nonmagnetic fraction of panned concentrates (Detra and others, 1977); it may represent mineralization along a fault in quartz-muscovite schist (qms) (Brosgé, oral commun., 1976). 3) Copper anomalies in the southwest corner of the map, just north of the South Fork Koyukuk River are in mafic rocks and chert (mrc) including volcanic rocks; they may represent normal copper contents for these materials. 4) Scattered high copper values in granitic rocks (gr) along the southern margin of the quadrangle probably represent small copper-rich veins.

Lead

Lead is the least abundant of the base metals in the Chandalar quadrangle and most anomalies are associated with the anomalies in copper and molybdenum already mentioned. The most significant area of lead anomalies is at the northern end of the northwest-southeast trending skarn type copper anomaly, just north of the North Fork Chandalar River; galena veins in Skajit Limestone (DSsk) were observed in the field. Spectrographic analyses of galena from these veins show it to be argentiferous with as much as 700 ppm silver.

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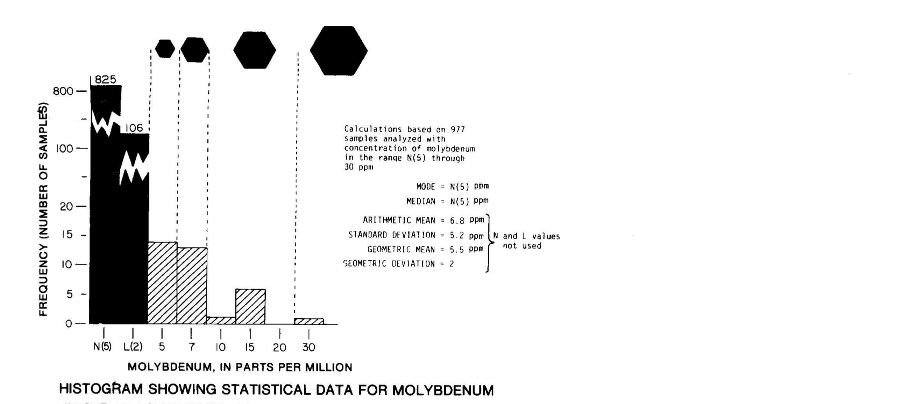
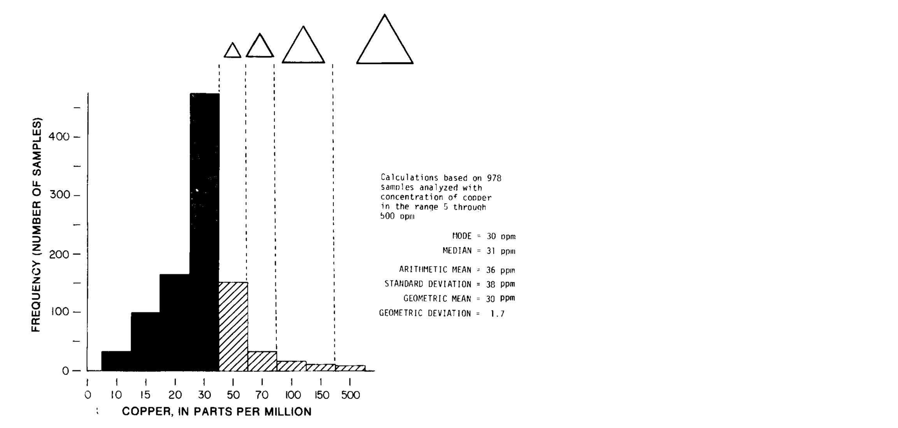
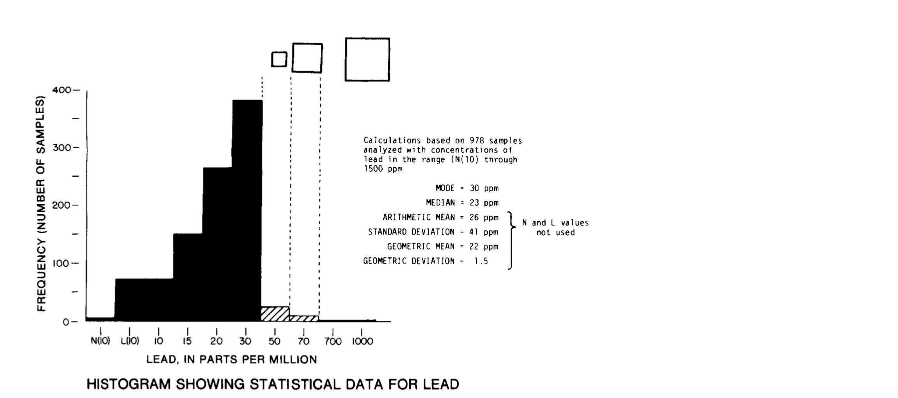


HISTOGRAM SHOWING STATISTICAL DATA FOR MOLYBDENUM IN STREAM SEDIMENTS, CHANDALAR QUADRANGLE, ALASKA



HISTOGRAM SHOWING STATISTICAL DATA FOR COPPER IN STREAM SEDIMENTS, CHANDALAR QUADRANGLE, ALASKA



HISTOGRAM SHOWING STATISTICAL DATA FOR LEAD IN STREAM SEDIMENTS, CHANDALAR QUADRANGLE, ALASKA

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