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GEOLOGY OF THE McKINLEY LAKE GOLD AREA

CHUGACH NATIONAL FOREST

SOUTH CENTRAL ALASKA

By: Joseph M. Haney and Uldis Jansons, Alaska Field Operations Center,

Anchorage, Alaska

* OPEN FILE REPORT (PROPOSED)

U.S. DEPARTMENT OF THE INTERIOR

Donald P. Hodel, Secretary

BUREAU OF MINES

Robert C. Horton

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This should be a number (1), not the letter I.

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UNIT OF MEASURE ABBREVIATIONS USED IN THIS REPORT

ft	foot, feet
in.	inch, inches
my	million years
oz	troy ounce, ounces
pct, %	percent
ppm	part(s) per million
sq mi	square mile(s)
T	ton, tons

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ABSTRACT

Gold prospecting and a limited amount of lode mine development occurred in the McKinley Lake area, south-central Alaska, prior to World War II. In 1980, the area was studied for the U.S. Bureau of Mines as part of a regional appraisal of minerals in the Chugach National Forest. Over 15 sq mi were mapped geologically, mining history was reviewed, mine workings were located and mapped, mineral showings were sampled, and the origin of gold deposits was studied.

Zones of potentially economic gold mineralization were not found. However, of the samples collected, minor amounts of gold were detected in 52 pct of the 168 rock samples. Over 40 pct of the samples of each major rock type (slate, graywacke, granite, and hornfels) contain detectable (>0.03 ppm) amounts of gold. Gold occurs most frequently in graywacke (in 66 pct of samples); highest gold concentrations (to 0.11 oz/T) are in samples of graywacke laced with quartz veinlets. Petrographic studies indicate that the gold content is often high and positively correlated with the degree of fracturing and recrystallization of quartz in veinlets or stringers. Higher gold values are present in samples with a higher arsenic content. Structural interpretation of the geologic and fluid inclusion data from quartz veins suggest that mineralization is post intrusion.

INTRODUCTION

McKinley Lake is 21 miles east-southeast of Cordova, 3 miles west of the mouth of the Copper River, and 8 miles north of the Gulf of Alaska (fig. 1). Prospecting for gold occurred mainly before 1920, but sporadic work continued

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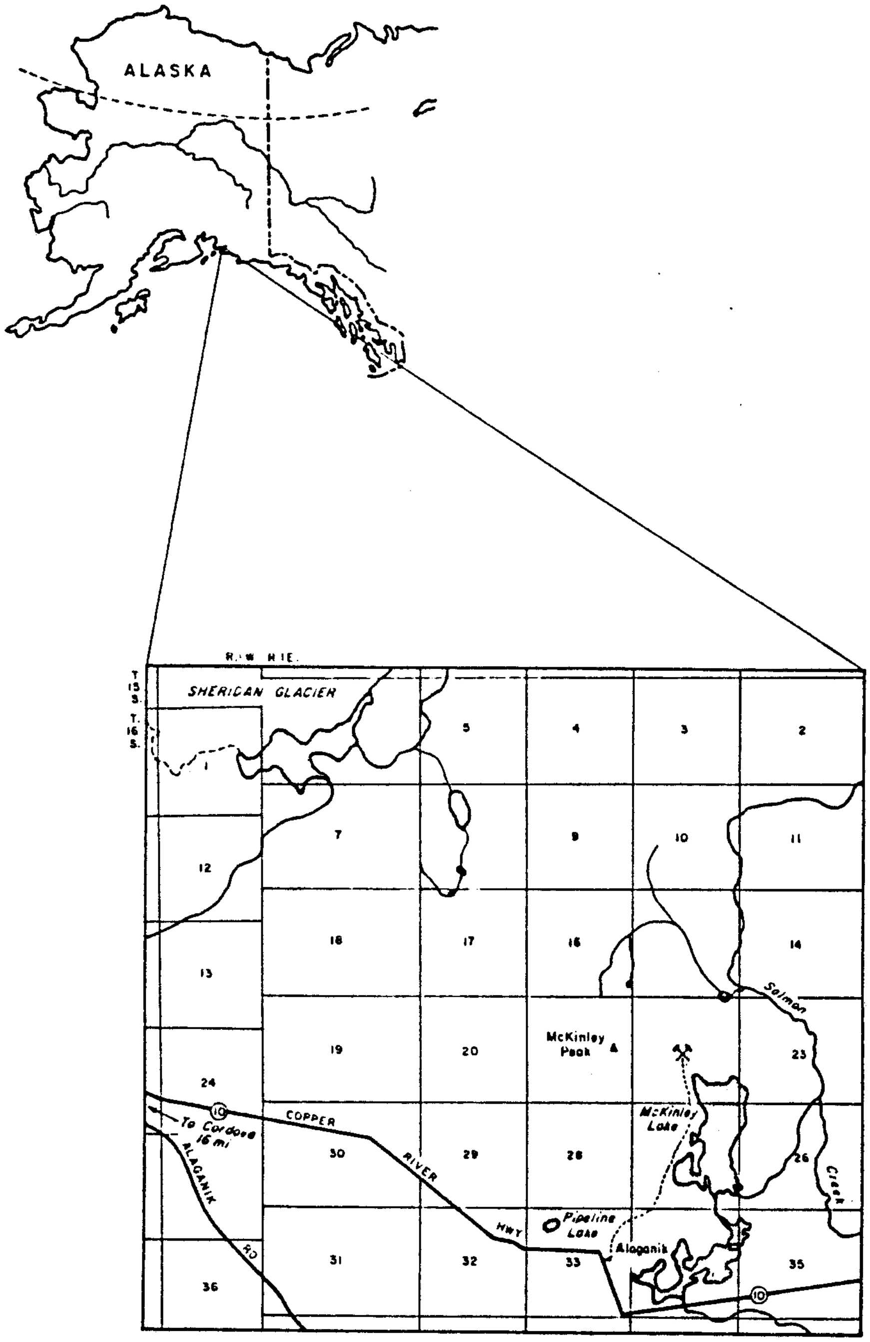

Figure 1.--Location of McKinley Lake mining area, Alaska.

up to World War II. Records of sustained gold production were not located, nor is there evidence of stoping in any of the prospects mapped in 1934 or investigated in 1980. Active lode mining claims existed in the area in 1983.

In the McKinley Lake area, gold is the primary mineral of economic interest. Silver and other metals are present but in quantities too small to be of economic interest.

Field work in 1980 included two months of regional geologic mapping and sampling of mineral prospects. The distribution of mineralization, mining history, and petrographic, geochemical, fluid inclusion, and regional structural data and their relation to gold mineralization are summarized in the following sections.

This report presents and discusses findings of mineral appraisal of a part of the Chugach National Forest, Alaska, and forms part of a larger evaluation of the mineral resources of the forest conducted in compliance with RARE II stipulations (17, 23)3/.

ACKNOWLEDGMENTS

Many of the results of this study are presented in detail in a Master of Science dissertation at the New Mexico Institute of Mining and Technology (NMIMT), Socorro, New Mexico, by the senior author (J.H.) (12). Field work and analytical work were supported by the Bureau of Mines.

Clay T. Smith of NMIMT served as thesis committee chairman for this study and the value of his suggestions cannot be over-emphasized. Chemical analyses were by TSL Laboratory, Spokane, Washington, and by the U.S. Bureau of Mines laboratory, Juneau, Alaska.

M.L. Silberman of the USGS reviewed the text and provided constructive criticism and comments on this report.

PREVIOUS WORK

Neither published engineering nor geologic reports on mineral occurrences in this area were located. Ten complete and partial unpublished reports, dating from 1912, on mineral occurrences were available in Bureau of Mines files (2, 4-6, 9, 13, 14, 25, 27, 28). While there are areas of agreement

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3/ Underlined numbers in parenthesis refer to reference listed at the end of this report.

among the investigators, considerable variation and disagreement exists on observations and in the interpretation of data.

The investigators generally agreed that:

1) Mineralized zones are in metasedimentary rocks.
2) A nearby granite pluton intrudes the Orca Group slates and graywackes.
3) Metallic minerals occur in quartz veins and, in addition to free gold, include: pyrite and arsenopyrite (both mentioned often); silver (in some assay results); pyrrhotite, galena, and stibnite (mentioned only once or twice).
4) Higher gold values are found more often in quartz veins in graywackes than in quartz veins in slates.
5) Quartz fissure filling occurs mostly parallel to bedding between slate beds, or between slates and graywackes, but is transverse to bedding most often in graywackes. Different observers called one or the other (that is, parallel or transverse) dominant, depending on workings examined.
6) The adits were driven without attention to geologic principles and are of little use for development of any mineral deposits.

Points of disagreement are:

1) Structural altitude of metasediments.
2) The presence of quartz diorite and diorite porphyry dikes.
3) The potential for the presence of economically significant deposits.

PRESENT INVESTIGATION

The Bureau of Mines initiated this investigation to:

1) Determine the character, extent, and origin of gold mineralization in the McKinley Lake area.
2) Locate and map mines and prospects.
3) Determine the geology and geochemistry of the deposits.
4) Evaluate the potential for gold mine development, especially large-tonnage low-grade lode deposits in metasedimentary rocks.
5) Identify the source of the gold.

The regional geology as well as individual prospects were mapped and sampled. An attempt was made to locate all reported workings; of those located, only four were accessible for mapping. Rock and mineral samples were collected throughout the area but most were taken from outcrop near prospects and from adits. The geochemistry of the host rocks and veins was determined. Fluid inclusion measurements were made to determine temperatures at the time of their entrapment, the salinity of trapped fluids, and to determine mineral genesis.

GEOLOGIC SETTING

The McKinley Lake area is underlain by metasedimentary rocks of the upper part of the early Tertiary Orca Group, which is intruded by a biotite granite pluton dated at 51.6±2.0 MY (36). The tectonic episode during which the Chugach Terrane, which includes the McKinley Lake area, was accreted to the continental margin terminated no later than 52MY ago (19, 29). The pluton, which intruded the metasedimentary rocks near McKinley Lake following intense deformation during their accretion, may be related to the eastern segment of plutons of the Sanak-Baranoff belt which ranges in age from 47 to 52 MY (15).

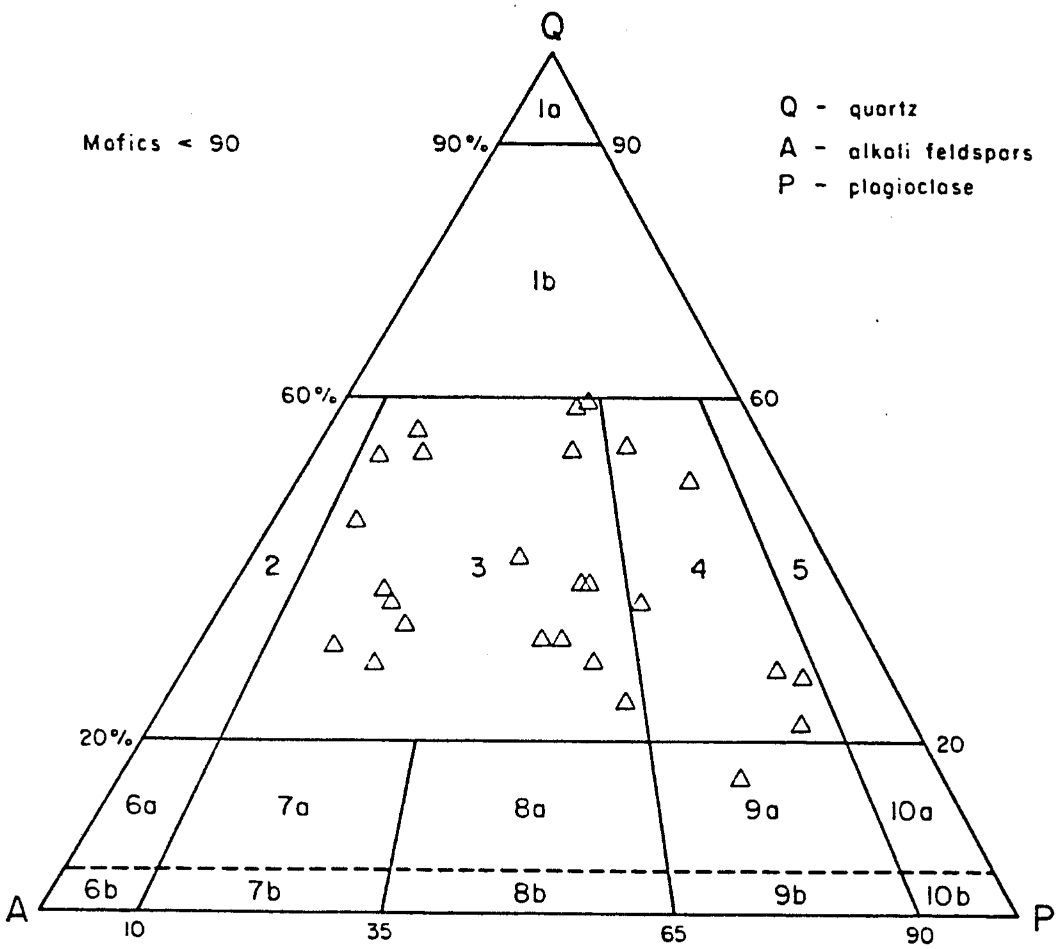
Rock Types and Alteration

Metasedimentary and igneous rocks underlie the study area (fig. 2). Graywackes, slates, and argillites make up most of the Orca Group. The volcanic and clastic lithologies of the Lower Orca Group are of probable middle-Eocene age (23). The upper age limit of the >10,000-ft-thick Orca Group is not known because diagnostic fossils have not been found nor is the group overlain by younger, dated rocks. An elongate biotite-granite pluton which intruded the Orca Group rocks 2 miles northwest of McKinley Lake, is nearly 2 miles wide and extends at least 5 miles along a N50-55E trend. The crystallization of the intrusive resulted mainly in granite with minor granodiorite and quartz monzodiorite facies (fig. 3, table 1).

At the granite-slate and the granite-graywacke contact, the intruded rocks have been metamorphosed to the albite-epidote hornfels facies (32). Hydrothermal alteration of the granite is common and widespread. The alteration has sericitized the feldspars (10 to 60 pct) and chloritized the biotite (up to 100 pct).

Structure

Regional folding and faulting apparently deformed the rocks prior to the intrusion of granitic rocks. Stereographic projection of fold axes on to a Schmidt net was used with limited success to determine possible fold relationships in the study area (fig. 4). The 15 fold domains identified between McKinley Lake and the granitic pluton emphasize the local structural



Ia	Quortzolite (silexite)
Ib	Quortz-rich gronitoids
2	Alkoli-feldspor gronite
3	Gronite
4	Gronodiorite
5	Tonolite
6a	Alkoli-feldspor quortz syenite
7a	Quortz syenite
8a	Quortz monzonite
9a	Quortz monzodiorite/quortz monzogobbro
10a	Quortz diorite/quortz gobbro/quortz onorthosite
6b	Alkoli-feldspor syenite
7b	Syenite
8b	Monzonite
9b	Monzodiorite/monzogobbro
10b	Diorite/gobbro/onorthosite

(GEOTIMES, October 1973)

Figure 3.--Igneous rocks in the McKinley Lake area, Alaska.

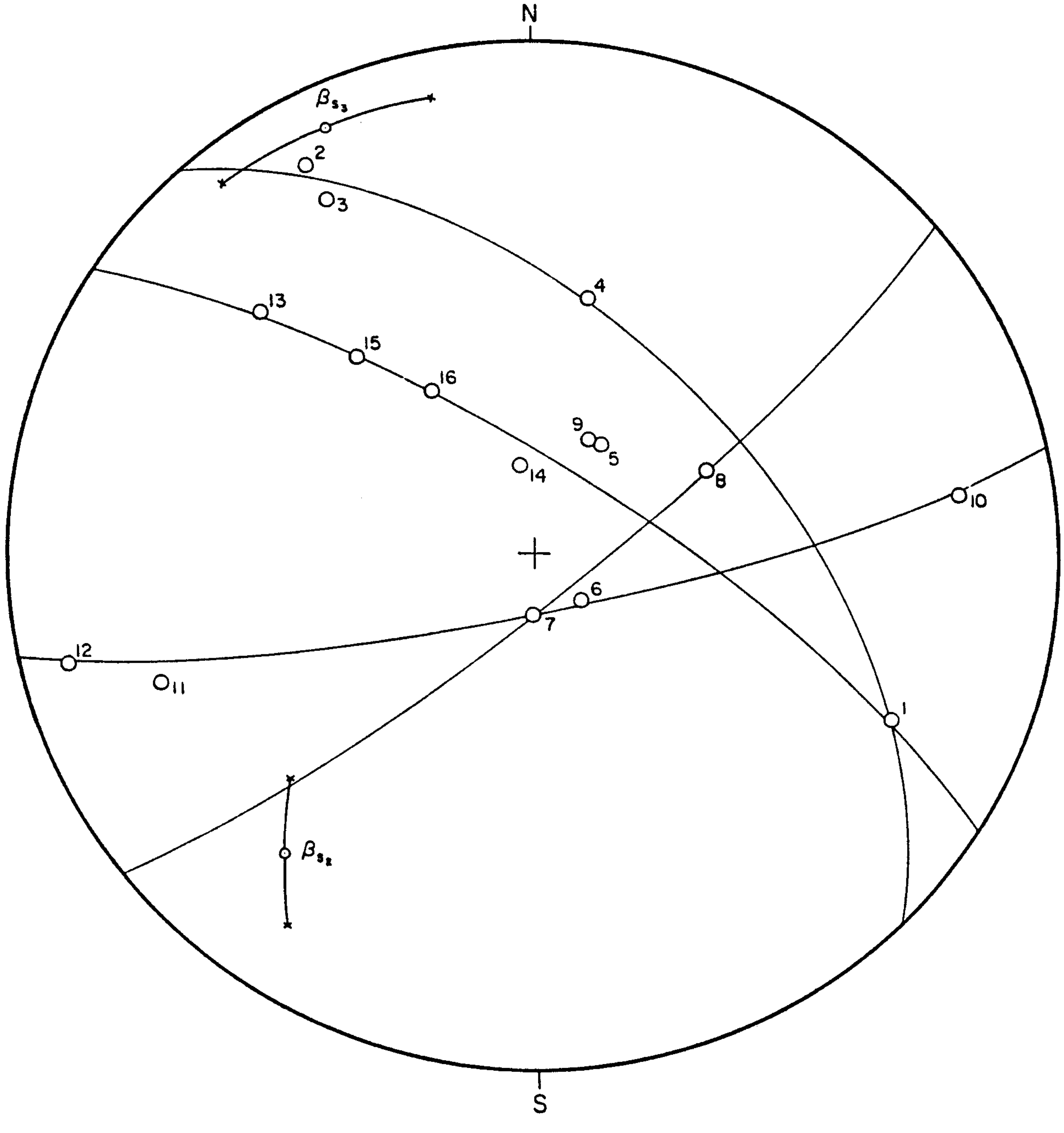


Figure 4.--Stereographic projections of fold axes, McKinley Lake area, Alaska. For distribution of fold domains, see figure 5.

Table 1.--Modal analyses of intrusive rocks from McKinley Lake area, Alaska.

Sample No.	QTZ pct	K-FLD pct	PLAG pct	BIOT pct	CHLR pct	MUSC pct	EPID pct	OPAQ pct	Trace Amounts
3111	24.7	26.2	28.3	15.1	5.1	---	---	0.7	ap, rut
3112	29.9	40.6	11.4	9.0	8.6	0.6	---	TR	NA
3113	38.3	25.0	9.0	3.3	18.5	1.5	4.3	1.3	zrn, ap, rut
3114	39.4	22.3	8.5	2.1	8.9	---	18.2	0.5	ap, zrn, rut
3115	26.3	46.2	11.8	4.5	8.6	0.7	1.5	.5	ap, mona
3116	20.0	36.0	13.3	14.0	14.4	---	1.1	.7	zrn, rut
3117	25.8	26.8	16.0	12.9	4.7	---	3.0	.8	zrn, spl, ap
3118	26.0	18.0	24.0	4.0	12.0	---	14.0	1.0	ap, zrn
3119	21.0	8.0	45.0	21.0	4.0	---	---	TR	ap
3121	21.0	25.3	41.7	TR	5.2	6.8	---	TR	ap
3126	13.0	17.0	50.0	---	20.0	---	---	TR	ap, mona
3133	28.7	21.9	20.0	11.2	17.0	0.6	---	0.5	ap
3134	18.0	10.0	54.0	13.0	4.0	---	---	1.0	ap
3135	22.0	7.0	53.0	17.0	---	---	---	TR	ap, zrn, tour
3137	32.0	22.0	30.0	2.0	11.0	TR	3.0		NA
3140	25.0	25.0	35.0	2.0	8.0	---	1.0	1.0	mona
3141	23.2	21.9	26.3	2.1	25.8	---	TR	2.4	zrn
3142	32.0	24.0	4.0	8.0	12.0	---	20.00	0.5	NA
3144	48.0	14.0	20.0	---	7.0	9.0	2.0	TR	NA
3148	34.0	9.0	14.0	3.0	12.0	2.0	26.0	0.03	rut
3151	30.4	30.6	6.3	12.2	4.4	5.7	7.9	1.0	ap
3153	40.0	15.0	19.0	11.0	8.0	6.0	---	1.0	ap
3155	29.0	17.0	34.0	3.0	5.0	9.0	---	3.0	NA
3157	42.0	11.0	25.0	15.0	4.0	---	2.0	2.0	ap
3188	44.0	9.0	35.0	8.0	3.0	---	---	1.0	NA
3189	24.0	31.0	11.0	---	2.0	30.0	---	1.0	NA
arithmetic average	29.1	21.9	24.9	7.4	9.0	2.8	4.1	0.9	

ap - apatite
zrn - zircon
rut - rutile
mona - monazite
tour - tourmaline

TR - trace amount
--- - not detected
NA - not applicable

complexity (fig. 5). Axial trends and plunges divide the structures into separate phases but they probably are related genetically.

The style of folding and faulting is most apparent along the ridge at Tip Top Mt., when the nearly vertical west face is viewed (fig. 6). Here tight to isoclinal folds, separated by north-dipping thrust faults, are all overturned to the south. From McKinley Lake northwest, toward the pluton, all beds dip northerly until a dip reversal occurs within 0.25 miles from the intrusive, where beds dip steeply southeast. Structural cross-sections show most probable trends of folding (fig. 2), but verifying stratigraphic correlation is lacking.

The continuity of faulting could be observed in the field only across the cirque located across the horseshoe shaped ridge in sections 15, 16, and 21. However, three sub-parallel sets of continuous lineations, which can be seen on aerial photographs, in the metapelites and the granitic pluton are shown on fig. 2. This suggests that at least some fracturing post-dated the intrusion and cooling of the pluton.

MINE WORKINGS

The distribution of mine workings in the McKinley Lake area, as mapped in 1934 (25) is shown on fig. 7 and as identified in 1980 on fig. 2. The workings are commonly placed into four groups:

A. Lucky Strike group workings, on the easterly slopes of Tip Top Mt., were developed before 1912. By 1912, development included three "tunnels" totaling 400 ft of workings (5).

B. McKinley Mining (Pioneer) group workings are on the easterly slopes of McKinley Peak as well as those east of the saddle north of that peak. By 1912, two adits in this group contained more than 600 ft of workings (5).

C. Rilley claim group, along the forest trail between the Lucky Strike and McKinley Mining (Pioneer) groups, included six adits at an elevation of approximately 300 ft. All adits reportedly followed quartz veins in slate but none contained good mineral showings (4).

D. Bear Creek group (5, location not specified), on southeast striking beds near the granite intrusive on the northeast side of Tip Top Mt., was said to be geologically similar to other claim groups. Additional information concerning this property was not located nor were any of the workings located in 1980.

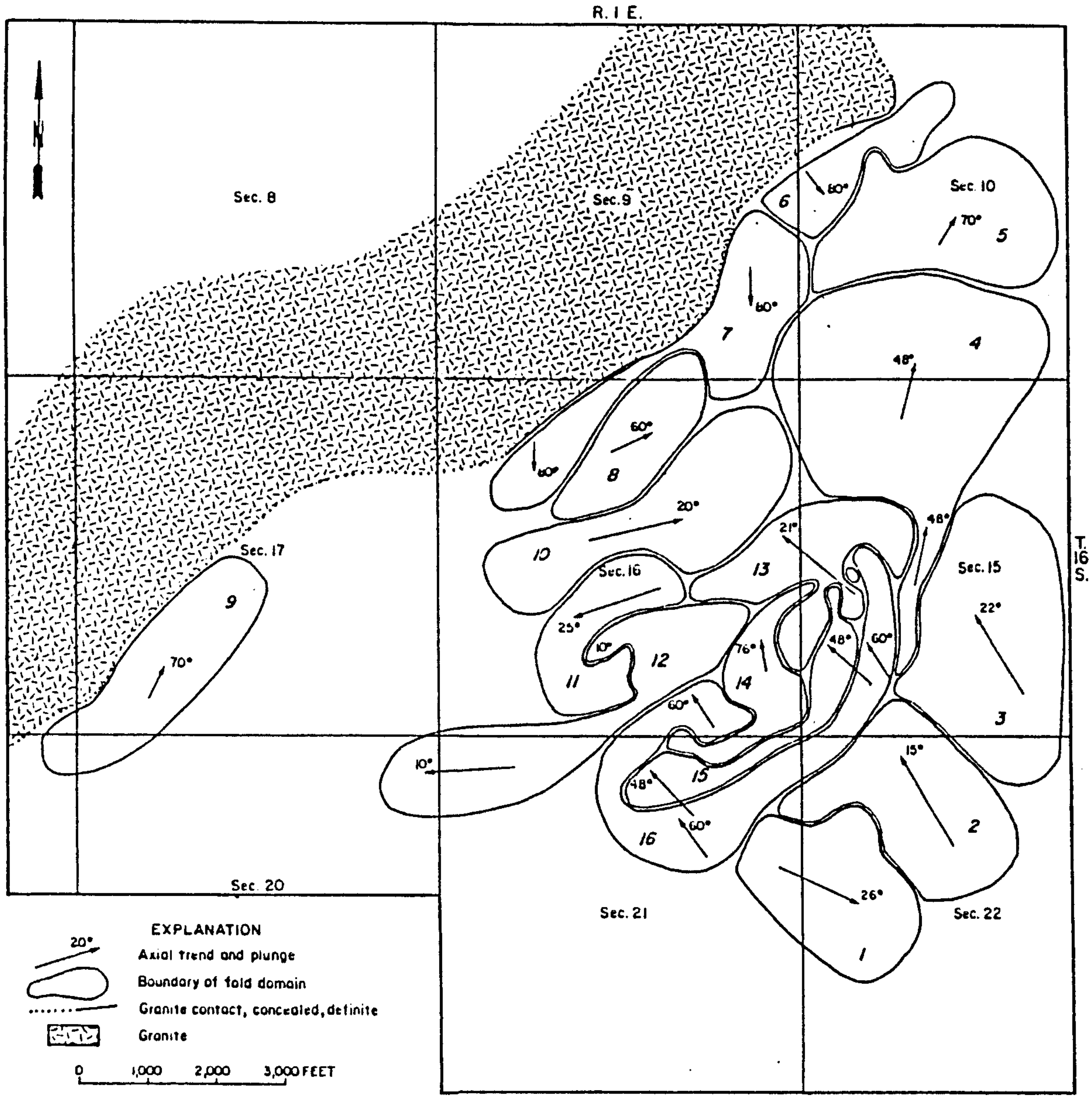


Figure 5.--Fold domains and axial trends of structures in the McKinley Lake area, Alaska.

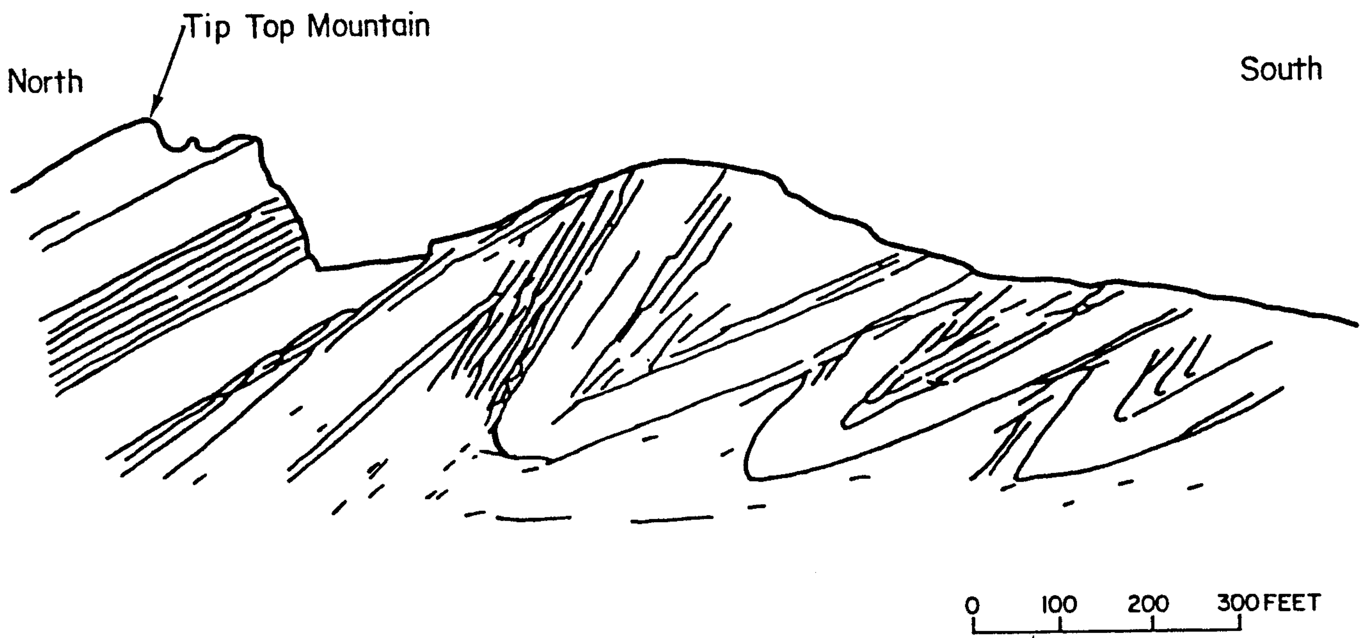


Figure 6.--Field sketch showing the style of folding and faulting on face of Tip Top Mountain ridge, McKinley Lake area, Alaska.

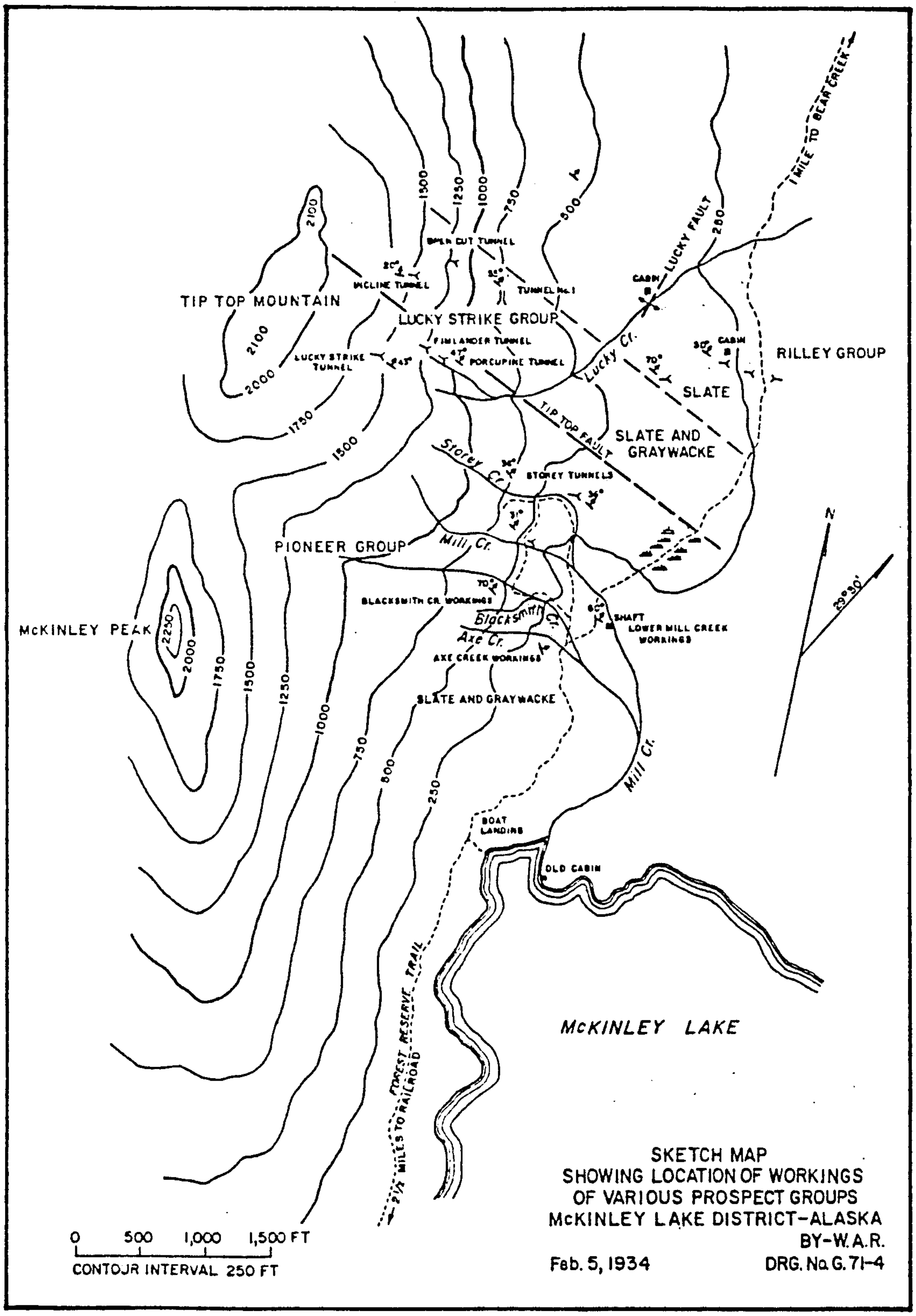


Figure 7.--Location of mine workings in McKinley Lake area, Alaska (from Richelsen, 1934).

Previous Examinations

Most of the past mining activity occurred at the McKinley Mining (Pioneer) group (1,410 ft of workings) and the Lucky Strike group (more than 1,097 ft of workings). At least 2,540 ft of workings, including 17 adits, cross-cuts, and drifts were reported to be developed. Largest of these is the Story Creek "tunnel", containing 585 ft of crosscut and 157 ft of drifting. The lower McKinley "tunnel" was driven 564 ft.

Only the Lucky Strike and McKinley Mining (Pioneer) groups of workings continuously reported gold in assays over the years of prospecting, but the values were not consistent or reproducible. Although high gold assays, up to 1.0 oz/T (4), were reported from various samples collected from veins and dumps, the average for high grade zones was near 0.25 oz/T. Other samples reportedly yielded up to 9.0 oz/T, but Richelson (25) noted: "It is not quite understood how such encouraging assay returns are obtained unless the samples are 'picked' for they certainly do not indicate the general run of the ground."

Workings Examined in 1980

Four adits were open and could be mapped and sampled. Descriptions and analytical results for samples from the four adits are listed on tables 2 and 3.

1) McKinley Lake Lower Adit (fig. 8): The portal of the adit is at an elevation of 140 ft, 100 ft west of the remains of a ball mill on the west bank of Mill Creek. This adit was driven parallel to the strike of bedding in graywacke and intersected slate. The graywacke contains transverse quartz veinlets, up to 1 in. thick. A cave-in 16 ft inside the portal blocks further access. All four samples (3027, 3028, 3029, and 3201), three inside the adit and one from the dump, contained low gold values.
2) McKinley Lake Upper Adit (fig. 9): This 15-ft-long adit is at an elevation of 400 ft, and 0.1 mi west of the Lower Adit. The adit is driven on narrow (<0.5 in.) quartz veinlets in graywacke. Seven samples were collected in 1980 (3199, 3200, 3030-3034). Five samples of graywacke with quartz contained detectable gold; two of the graywacke without quartz did not.
3) Lucky Strike Adit (fig. 10): The portal of this 516-ft-long adit is at an elevation of 740 ft. Five of eight samples collected in the adit contained detectable gold values (3081, 3082, 3084, 3196, 3197).

Table 2.--Samples containing detectable gold values, McKinley Lake area, Alaska.

I. Detected by USBM or TSL to have >/=0.10 ppm gold:

Sample	TSL		USBM		
Number	oz/T	ppm	oz/T	type	Location
3004	NA	NA	0.02	gwk/qtz vns	Outcrop
3008	TR	0.05	.005	gwk/qtz vns	Outcrop
3014	NA	NA	.005	arg	Outcrop
3024	NA	NA	.04	slt/qtz	Outcrop
3027	TR	.30	NA	slt	McKinley Lower
3028	0.007	.25	NA	gwk/qtz vns	McKinley Lower
3029	.006	.20	NA	gwk	McKinley Lower
3031	.107	.42	.055	qtz in gwk	McKinley Upper
3032	.06	.25	.005	qtz in gwk	McKinley Upper
3047	NA	.10		slt	Outcrop
3048	NA	.10		slt/qtz vns	Outcrop
3071	.007	.21	.06	gwk/qtz vns	Outcrop
3076	TR	.10		gwk/qtz vns	Outcrop
3085	TR	.10		gwk/qtz vns	Outcrop
3090	.006	.13		qtz in gwk	Outcrop
3095	NA	.21	.02	gwk/qtz vns	Outcrop
3096	.016	.32		gwk/qtz vns	Outcrop
1097	NA	.10		hrf/qtz vns	Stringer
3112	NA	.10		grn	Outcrop
3113	NA	.07	.01	grn	Outcrop
3195	TR	.10	TR	gwk/qtz vns	Stringer
3199	.013	.25	TR	gwk/qtz vns	McKinley Upper
3200	.029	.75	missing	gwk/qtz vns	McKinley Upper
3201	TR	.10		gwk/qtz vns	McKinley Lower

II. USBM - detected gold by fire assay, or
TSL - detected gold by both fire assay and atomic absorption:

3007	TR	0.03		slt	Outcrop
3037	NA	NA	TR	arg	Outcrop
3049	NA	.04	TR	qtz in slt	Outcrop
3051	TR	.08		slt	Outcrop
3058		.03	TR	arg	Outcrop
3065	TR	.03		gwk w/slt	Outcrop
3081	TR	.09		gwk/qtz vns	Lucky Strike
3082	TR	.06		gwk/qtz vns	Lucky Strike
3092	TR	.09		slt/qtz vns	Outcrop
3099	TR	.05		gwk/qtz vns	Stringer
3121	TR	.04		arg/qtz vns	Outcrop
3170	TR	.03		slt/qtz vns	Outcrop
3192	TR	.05		hrf/qtz vns	Stringer
3193	TR	.05		qtz in gwk	Stringer

Table 3.--Analytical results and rock descriptions for Lucky Strike and McKinley Mining claim group areas: sections 15, 16, 21, 22; R1E, T16S, Cordova Quadrangle. Sample site on figure 2.

Sample No.	Thin Section Examined	Rock Description	Au ppm	Ag oz/T	Opaque Mineral	OPQ %	OPQ <=mm	CO3 %	QTZ vns <=mm	new QTZ =	Adit
Sect. 22											
NE qtr:											
3024	x	SLT, QTZ vns <15° to bddg	1.36	–	mag	1.0	0.01		0.5		
3027	x	SLT; 10mm interbdd GWK (40%)	.30	–	mag,apy,ilm	4.	.8				McKinley
3030		SLT & GWK interbdd	.13	0.2							McKinley
3029	x	GWK, fin (<.25mm); irreg QTZ vnlts	.20	–	apy,mag,py,po	5.7	.4	1.9	1		McKinley
3201	x	GWK; irreg QTZ vns	.10	–	hm,apy,ilm	4.0	.3	2.0	50	8	McKinley
3026	x	QTZ stockwork in GWK (40%)	–	–		3.5		–	25	–	
3028	x	QTZ stockwork in GWK (10%); vugs <15mm	.25	–	mag,apy,py	2.1	.4	–	25	4	McKinley
SW qtr:											
3035	x	ARG; few irreg QTZ vns	–	–	mag	2.	.01		.1		
NW qtr:											
3001	x	SLT; 4mm interbdd GWK (18%); 20 clvge	TR	–	hm,apy	1.	.1	TR			
3002	x	SLT; OPQ-filled fracts <.05mm; 6 clvge	–	–	hm,py,apy	2.	.05				
3006	x	SLT; 6 clvge angle	–	–	mag,hm	1.	.03				
3007	x	SLT; QTZ & EPD filled fracts	.03	.2	hm,mag,py,apy	5.	.05		.05		
3037	x	ARG	TR	–	hm,mag	2.	.2				
3044	x	SLT; 95% matrix; clvge 60° to bds	.03	–	py,mag,apy,hm	2	.05				
3062	x	SLT; 15% interbdd GWK; clvge 50 to bds	–	–							
3008		GWK; irreg. QTZ vns	.05	–	hm,mag	3.	.4		50		
3010	x	GWK; SLT lenses (6x3mm); QTZ vns	–	–	mag,hm,py,apy	8.1	.3	–	18	1	
3033	x	GWK; irreg QTZ vnlts	–	–	mag,ilm,py,cpy,apy	3	.5		2		McKinley
3034	x	GWK; OPQs along fracts (45° to bddg)	–	–	mag,py,apy	8.3	.4				McKinley
3039	x	GWK; 60.5% matrix	–	–	mag,hm	7.1	.2	.6			
3041	x	GWK	TR	–	mag	3.	.4				
3042	x	GWK; subprll SLT lenses <3mm (40%)	–	–							
3031	x	QTZ vns in GWK; 25% K-FLD	3.64	.4	apy,hm,mag	<1	.3	–	600	2	McKinley
3032	x	QTZ vns in GWK; GWK clasts <10mm	2.04	.2	apy,hm,mag,ilm	2.6	.4	–	600	5	McKinley
3056		QTZ stockwork between SLT and GWK	Tr	.2					25		
3199	x	QTZ, vns; 17% K-FL; 2% GWK clasts	.44	–	apy,hm,mag	1	.4	TR	12		McKinley
3200	x	QTZ in GWK breccia; 15% K-FLD	.99	–	apy,mag,hm,ilm	1.7	.15	–	25	20	McKinley

Table 3.--Analytical results and rock descriptions for Lucky Strike and McKinley Mining claim group areas: sections 15, 16, 21, 22; RIE, T16S, Cordova Quadrangle. Sample site on figure 2--Continued

Sample No.	Thin Section Examined	Rock Description	Au ppm	Ag oz/T	Opaque Mineral	OPQ %	OPQ <=mm	CO3 %	QTZ vns <=mm	new QTZ =	Adit
Sect. 15											
SW qtr:											
3077		SLT; QTZ vns	0.08	–					18		
3078		SLT; crenulated; GWK lenses	.03	–							
3079	x	SLT; 5mm GWK bed; QTZ vnlts; 30 shears	–	0.2	hm	1	0.2				Lucky Strike
3080	x	SLT; 91% matrix; clvge 20 to bddg	–	–		2					Lucky Strike
3092	x	SLT; trnsvers QTZ vnlts	.09	–	mag,py	2	.2		5		
3100	x	SLT; 92% matrix; clvge 50 to bddg	–	–	mag,py	3	.05				Stringer
3064		GWK; irreg QTZ vns; ARG clasts	–	–		1		–	18	–	
3065		GWK; fine; ARG clasts; irreg QTZ vnlts	.03	–					1		
3076	x	GWK; 55% matrix; QTZ vns	.10	–	hm,mag,py	3	.4		12		
3081	x	GWK; irreg QTZ vns	.09	–	mag,apy,py	2	.4	7	35	30	Lucky Strike
3085		GWK; irreg QTZ vns	TR	–					25		
3093	x	GWK; trnsvers QTZ vnlts w/OPQS	.04	–	py,ilm,mag	1	.4		12		
3094	x	GWK; irreg QTZ vnlts	.04	–	apy,py,hm	2	.5		12		
3095	x	GWK; irreg QTZ vns	.68	3.4	apy,py,hm	6	.2	.9	25	3	
3102	x	GWK; irreg QTZ vns; OPQ, 10% euhed apy	TR	–	apy,py,mag	6	1.2	–	75	<1	Stringer
3194	x	GWK; sheared; QTZ vns; 23% chlr/ser	.08	–	apy,mag,py,ilm	5	.4		25		Stringer
3195	x	GWK with QTZ (75%) - CO3 (25%) vns	.10	–	apy,po,mag,py	6	.3	25	18		Stringer
3197	x	GWK; breccia; QTZ cement	.04	–	hm,mag,ilm,apy	4	.6		18		Stringer
3063		QTZ; of vns in GWK; vugs <2x5mm	–	.2		<1		–	100	<1	
3082	x	QTZ; 12% GWK clasts	.06	–	py,hm,apy	<1	.4	8	50	1	Lucky Strike
3083	x	QTZ; in GWK (30%)	–	–	py,hm,apy,mag	1	.8	15	25	1	Lucky Strike
3084	x	QTZ; in GWK (5%)	TR	.2	hm,apy,mag	<1	.2	5.8	35	2	Lucky Strike
3096	x	QTZ; vn in GWK; 5% GWK clasts	.54	.32	mag,ilm,py,apy	2.7	.8	–		1	
3098	x	QTZ, vn in GWK; 10% GWK clasts	–	.2	ilm,mag,py,apy	<1	.5	TR	50	3	Stringer
3099	x	QTZ from 2' "gouge" zone in GWK	.05	–	hm,apy,mag,py	1.4	.2	5	50	25	Stringer
3101	x	QTZ vns in GWK; 5% GWK clasts	TR	–	hm,apy,py	1.2	1.5	–	50	3	Stringer
3193	x	QTZ, "hi-grade"; 50% alt'd GWK clasts	.05	–	hm,mag,apy,py	7	.5	15	25	10	Stringer
3196	x	QTZ vns in GWK (45%)	.03	–	mag,ilm,cpy,apy	2	.3		10		Lucky Strike
3097	x	HRF; many irreg QTZ vns	.10	.2	mag,hm,py,apy,cpy	2	.4	–	37	60	Stringer
3192	x	HRF (<60% ser, chlr) breccia; QTZ vns	.05	–	mag,ilm	7	1.0	6	37	2	Stringer
NW qtr:											
3048	x	SLT, crenulated; QTZ vnlts prlls beddg	.10	–	mag,hm	2	.4		6		
3050	x	SLT, clvge prlls beddg, OPQs line QTZ vnlts	–	–	hm,mag	2	.03		.1		
3049	x	QTZ in SLT	.04	–	hm,apy,py	<1	.1	–	50	20	

Table 3.--Analytical results and rock descriptions for Lucky Strike and McKinley Mining claim group areas: sections 15, 16, 21, 22; RIE, T16S, Cordova Quadrangle. Sample site on figure 2--Continued

Sample No.	Thin Section Examined	Rock Description	Au ppm	Ag oz/T	Opaque Mineral	OPQ %	OPQ <=mm	CO3 %	QTZ vns <=mm	new QTZ =	Adit
Sect. 16											
<u>NE qtr</u>:											
3106	x	SLT & GWK interbdd; "QTZ" vn 60% EPD	-	0.1	py,hm,mag	<1	0.1	-	18	-	
3107	x	ARG; QTZ/EPD fill in brec'd part	-	.1	hm,py,mag,apy	2	.5	-	3		
3109	x	SLT: crenulated & brec'd; QTZ vns	TR	.2	po,hm,apy,py	3	1.0	-	12	1	
3105	x	QTZ, irreg vns in interbdd SLT & GWK	-	-	hm,apy,mag,py	2.4	.3	-	18	2	
3108	x	QTZ, vns in interbdd SLT & GWK	-	-	mag,py,apy,ilm	2.6	.3		50		
3110	x	HRF, spotted; 65% BIOT; QTZ vnlts	0.03	-	hm,apy,mag,po	2	.3		1		
<u>SE qtr</u>:											
3072		SLT	TR	-							
3086		SLT; trnsvers QTZ vnlts	-	-					.1		
3088		SLT; few QTZ vnlts	-	-					12		
3087		GWK; QTZ vnlts	.04	-					3		
3089	x	GWK; irreg QTZ vnlts	.06	-	hm,py,mag	1	.2		25		
3090	x	QTZ lense (6" x 3') in GWK	.20	-	hm,mag,py	1.2	.3	1.9	150	20	
<u>NW qtr</u>:											
3166	x	SLT; brec'd; QTZ & OPQ fill; 88% matrix	TR	.4	py,hm,mag,apy	2	.4		3		
Sect. 21											
<u>NE qtr</u>:											
3003	x	SLT; clvge 12 to bddg planes	.05	-		3	.03				
3012	x	SLT; interbdd GWK (40%); QTZ vnlts	TR	.2		2	.02		.1		
3040	x	SLT: 92% matrix	-	-		5	.15				
3051	x	SLT; 88% matrix	.08	-	mag,py,hm	2	.1		.1		
3052	x	SLT; 94% matrix; QTZ vns; 2mm shear	-	-	hm,py,mag	1	.4		12		
3053	x	SLT; QTZ vnlts <40 to bddg	.05	-	hm,mag	1	.04	3	.2		
3055	x	SLT; QTZ vnlts shears (<1mm)	TR	.6	py,mag	5.9	.4		25		
3058	x	SLT; crenulated; irreg QTZ vnlts	.03	.4	mag	3	.01		.4		
3069	x	SLT; QTZ vnlts	-	-					.1		

Table 3.--Analytical results and rock descriptions for Lucky Strike and McKinley Mining claim group areas: sections 15, 16, 21, 22; RIE, T16S, Cordova Quadrangle. Sample site on figure 2--Continued

Sample No.	Thin Section Examined	Rock Description	Au ppm	Ag oz/T	Opaque Mineral	OPQ %	OPQ <=mm	CO3 %	QTZ vns <=mm	new QTZ =	Adit
3004	x	GWK; irreg QTZ vnlts	0.68	-	mag,apy	4	0.4		12		
3013	x	GWK; 2.5mm interbdd SLT; OPQs in fracts	.34	-	hm,py,mag,apy	8	.4		-		
3038	x	GWK; 57.5% matrix	-	-	mag,py	6.6	.4		-		
3059	x	GWK; QTZ vns and lenses	-	-	hm,mag	2	.05	5	25		
3060	x	GWK; irreg QTZ vnlts	.03	-	hm,mag	3	.12		1		
3061	x	GWK; interbdd SLT 5mm (40%)	.05	-	mag,hm,py	8	.1	12			
3068	x	GWK; 50% matrix; irreg QTZ vns	.05	0.2	hm,py,ilm,mag	1	.2	9	100	1	
3070		GWK; QTZ lenses and vns	-	-					10		
3071	x	QTZ vns/GWK; 30% GWK clasts (most OPQs)	2.04	.2	mag,py,hm,apy	3.3	.3	3.5	4	5	
3005	x	QTZ vn; 2% ARG frags (<0.5mm)	-	-	ilm,py,hm,mag, apy,cpy	1.5	.1	80	2		
3054	x	QTZ stockwork in SLT	-	-			<1	5	50	20	
3067	x	QTZ stockwork in GWK; vugs <2x4mm	TR	-		<1			25	3	
NW qtr:											
3014	x	SLT, broken and sheared; QTZ vnlts	.17	-	hm,mag	1	.4		.5		
Sect. 3 NE qtr:											
3202	x	GRN; dike; HRF contact	.05	-	mag,ilm	1	.3	-	18	-	
3203	x	HRF; QTZ vns; 12% EPD cement	.05	-	mag,hm,ilm,py,apy	5	.4	-	75	1	
Sect. 5 NE qtr:											
3133	x	GRN, x'tls <2mm; FLD alt'd <40%; chlr'ztn	-	-	ilm,mag,py	.5	.2				
3137	x	GRN 66%; HRF 33%; Plag alt'd <30%; chlr'ztn	-	.6	hm,py,mag,cpy	TR	.2				
3135	x	GDR, x'tls <2mm; FLD alt'd <40%; chlr'ztn	-	-	ilm,hm,mag	TR	.1				
3130	x	HRF; QTZ & EPD (drusy) fract fill	-	.2	hm,py,magapy	1.	.2		10		
3131	x	HRF; irreg QTZ vns (40%) with 20% BIOT	-	-	ilm,hm,py	<1	.15		175		
3132	x	HRF; chert lenses; irreg QTZ/EPD vns	-	.2	mag,hm,py,ilm	<1	.2		6		
3136	x	HRF; ARG lenses <3mm	-	.2	apy,pent,hm	<1	.15				
3137	x	GRN 66%; HRF 33%; PLAG <30% alt'd; chlr'ztn	-	.6	hm,py,mag,cpy	TR	.2				
3138	x	GRN 50%; GWK 35%; HRF 15% (from ARG)	-	.2	mag,py	TR	.05				

Table 3.--Analytical results and rock descriptions for Lucky Strike and McKinley Mining claim group areas: sections 15, 16, 21, 22; RIE, T16S, Cordova Quadrangle. Sample site on figure 2--Continued

Sample No.	Thin Section Examined	Rock Description	Au ppm	Ag oz/T	Opaque Mineral	OPQ %	OPQ <=mm	CO3 %	QTZ vns <=mm	new QTZ =	Adit
SE qtr:											
3111	x	TRN; x'tls <3mm; FLD <30% ser alt'd	0.5	0.2	mag,hm,ilm,apy	0.7	0.3				
3112	x	GRN, x'tls <3mm; chlr'ztn	.10	–	mag,hm,ilm,apy	TR	.2				
3113	x	GRN, x'tls <3mm; FLD <50% ser alt'd	.34	.1	hm,mag,ilm	1.3	.15				
3114	x	GRN, x'tls <2mm; EPD fill; FLD <40% alt'd	–	.2	ilm,py,mag	TR	.1				
SW qtr:											
3140	x	GRN, x'tls <2.5mm; alt'd FLD & BIOT; EPD vns	–	.2	mag,py,pent	1.	.5		0.2		
3141	x	GRN, x'tls <3.5mm; alt'd FLD & BIOT <100% missing	–	–	mag,hm,apy,py	2.4	.2				
3144	x	GRN dike, x'tls <2mm; FLD clasts <60% alt'd	.06	–	ilm,py,mag	TR	.1				
3142	x	GRN-HRF (from GWK) contact; EPD cement	.05	–	mag,ilm,apy,pent	3.	.9				
3188	x	GDR dike-HRF (50% BIOT) contact	.07	.2	apy,ilm,hm	1.	.3				
3189	x	GRN dike-HRF (60% ser & chlr) contact	.03	.1	mag,hm,py,ilm	1.	.2				
Sect. 6 SE qtr:											
3151	x	GRN, x'tls <3mm; FLD <50% alt'd	–	.2	mag,py,hm	1.	.5				
3153	x	GRN, x'tls <4mm; FLD <30% alt'd	.03	–	mag,hm,ilm	<1	.2				
3155	x	GDR, x'tls <3mm; FLD alt'd <40%	.04	–	ilm,py,mag,apy	3.	.5				

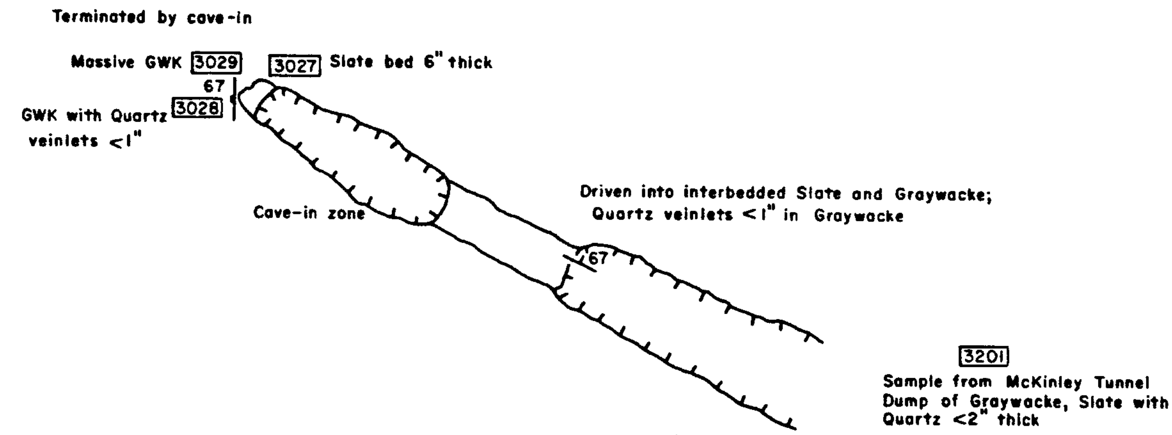
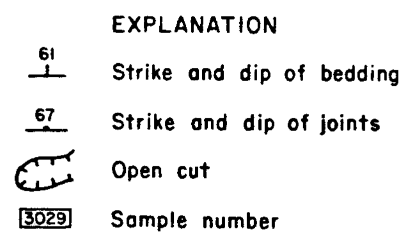


Figure 8.--McKinley Lake Lower Adit and sampled sites. As mapped in 1980.



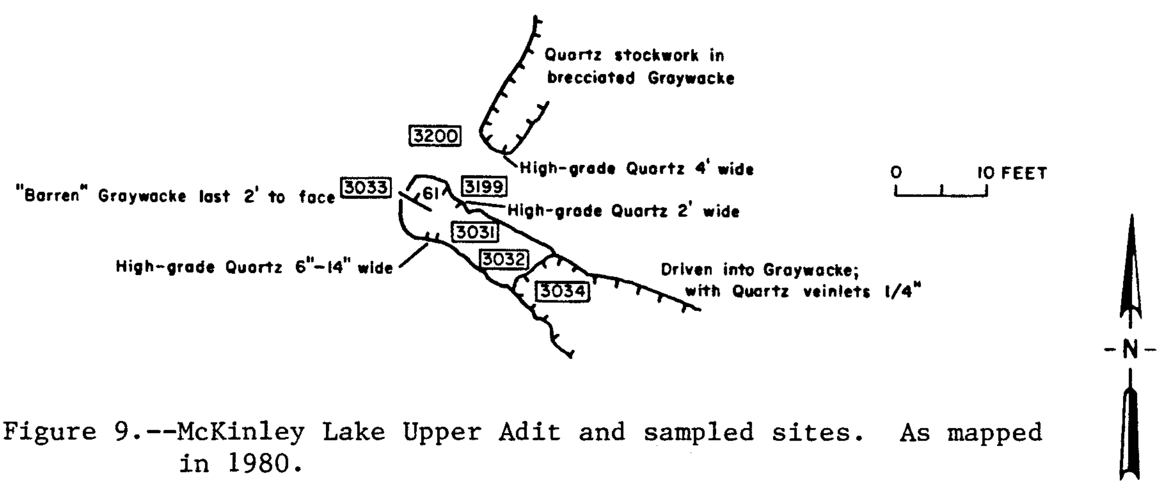


Figure 9.--McKinley Lake Upper Adit and sampled sites. As mapped in 1980.

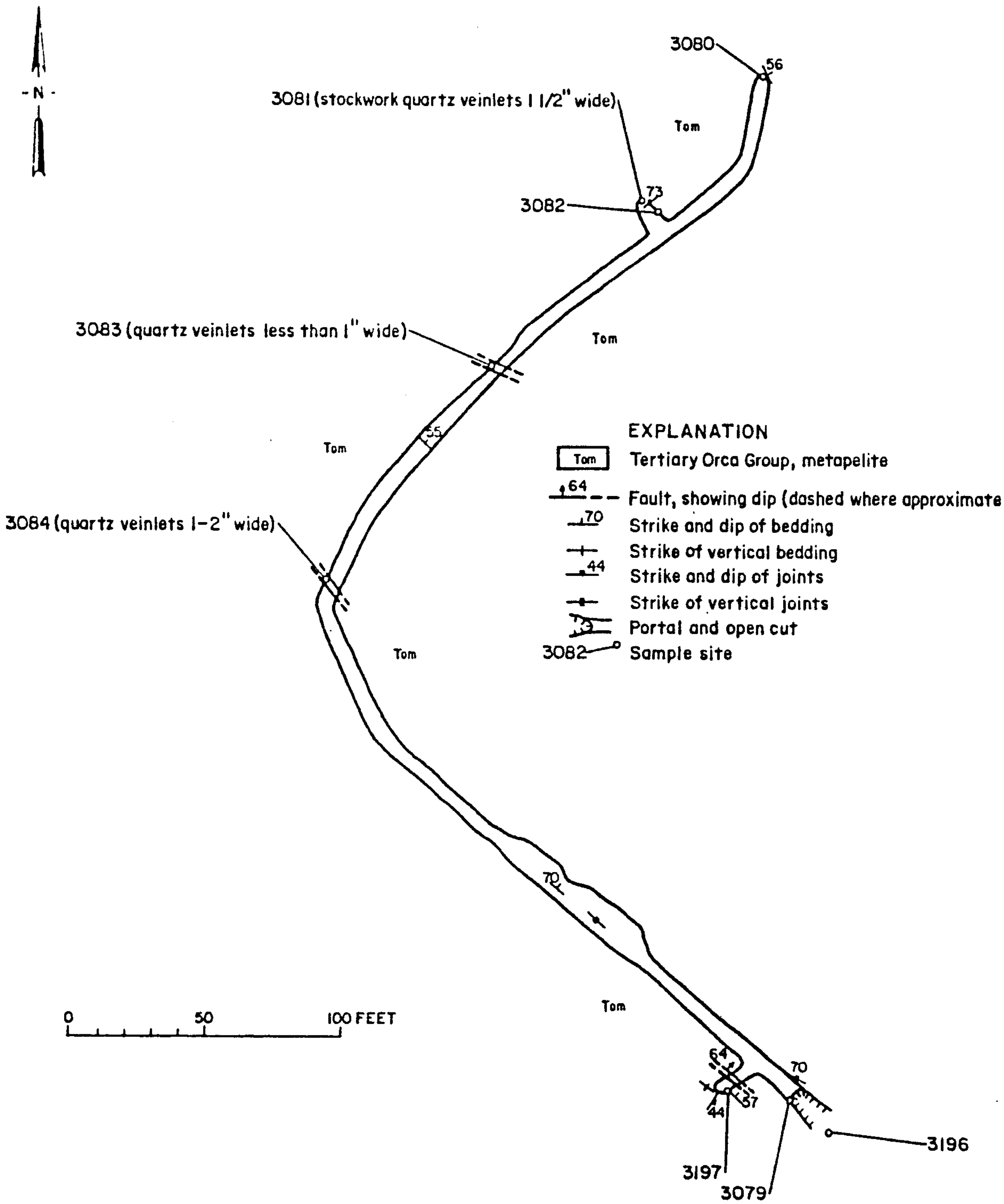


Figure 10.--Lucky Strike Adit and sampled sites. As mapped in 1980.

4) Stringer adit (fig. 11): The portal of the 43-ft-long Stringer Adit is on the northeast slope of Tip Top Mt. at an elevation of 1,075 ft. The Stringer Adit is here so called because it is driven on a shear zone filled with many quartz 'stringers'. (It is not the same adit referred to in old reports as the "Stringer Incline Tunnel"). The adit was driven on a 2-ft-wide shear zone sub-parallel to the strike of graywacke beds. In the adit, the shear zone contains quartz stringers (<2-in.-thick) along the interval from the portal to the turn at survey station #2. Of 10 samples collected in 1980 (3095, 3099, 3100*, 3101, 3102, 3192, 3193, 3194, 3195, 3196), 8 contain detectable gold.

LABORATORY RESULTS

Petrographic analysis of the host rocks and quartz veins, geochemical studies, and fluid inclusion measurements on the quartz were made to study vein genesis.

Petrography of Host Rocks

Metasedimentary rocks at McKinley Lake are predominantly argillaceous, rarely contain more than 50 pct grains larger than silt size, and are metapelites. Most of the rocks with <15 pct of the grains exceeding silt size possess cleavage or foliation independent of bedding and as a whole are slates. The term argillite is used here for argillaceous rocks with <15 pct of the silt-size grains, but without characteristic cleavage or foliation. Those with <15 pct silt-sized grains are called graywackes. Although the grains are seldom angular they are almost always poorly sorted.

The graywackes contain from 1 to 10 pct opaque minerals while the slates usually contain less than 2 pct opaque minerals. Grains are principally quartz and feldspar, while the matrix is generally composed of, in decreasing order of abundance: chlorite, sericite, quartz, opaque minerals, ±epidote. This mineral assemblage places the metapelites in the chlorite zone of the greenschist facies.

Petrography of Quartz Veins

Quartz veining occurs in both slates and graywackes but is more abundant in the graywackes (tables 3, 4). Individual veinlets are not continuous for more than several feet and rarely reach thicknesses of 4 in., with the 0.4 to

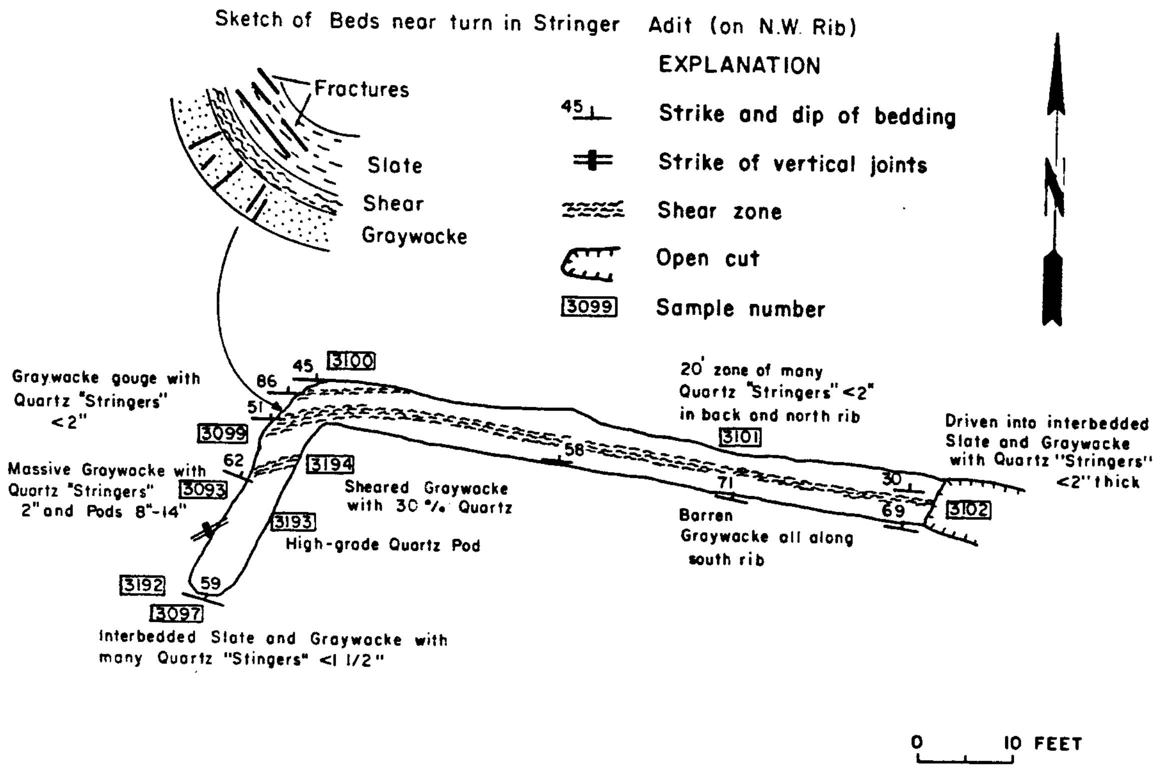


Figure 11.--Stringer Adit and sampled sites. As mapped in 1980.

Table 4.--Analytical results and rock descriptions for samples collected in sections 10, 17, 20; RIE, T16S, Cordova Quadrangle, Alaska.

Sample No.	Thin Section Examined	Rock Description	Au ppm	Ag oz/T	Opaque Mineral	OPQ %	OPQ <=mm	CO3 %	QTZ vns <=mm	new QTZ =	Adit
Sect. 10											
SW qtr:											
3046		SLT, crenulated; irreg QTZ vns	0.05	0.2		5	0.05		18		
3047	x	SLT, crenulated; irreg QTZ vnlts	.10	–	mag,hm	5	.1		3		
3167	x	SLT; trnsvers shear 0.5mm wide; QTZ vnlts	.03	–		3	.3		1.5		
3169	x	GWK, 53% matrix; QTZ vnlts	–	.2	mag	2	.4		3		
3170	x	QTZ vn; ARG clasts <2x3mm; EPD cement	.03	–	ilm,py,mag,hm	4.5	.8	25			
NW qtr:											
3177	x	GWK, 78% matrix; EPD & QTZ cement	–	.2	py,mag	1	.2	12			
3180	x	GWK, brec'd; EPD cement	–	–	py	2	.15		1		
Sect. 17											
SW qtr:											
3162	x	GWK, 53% matrix; EPD & QTZ cement	missing		mag,py	2	.6		6		
Sect. 20											
NE qtr:											
3019	x	SLT; shears 60° to bddg w/QTZ, CO3, OPQs	–	–		1	.1	2	.5		
Sect. 7											
NE qtr:											
3116	x	GRN, x'tls <3mm; chlr'ztn; ser'ztn	–	–	mag,ilm,hm	.7	.15				
3118	x	GRN, x'tls <3mm; FLD <30% alt'd; chlr'ztn	–	–	mag,hm	1.	.2				
SE qtr:											
3117	x	GRN, x'tls <4mm; chlr'ztn; ser'ztn	.03	–	ilm,mag,po	.8	.1				
NW qtr:											
3119	x	GDR, x'tls <4mm; FLD <10% alt'd	–	.2	ilm,mag,py	TR	.15				
3120	x	HRF; QTZ lenses 12x25mm; 2% gar	–	–	mag,apy,cpy,py	1.4	.5		12		
3121	x	GRN, chlr'ztn; HRF 10%; FLD <30% alt'd	.04	–	ilm,mag,apy	TR	.05				

Table 4.--Analytical results and rock descriptions for samples collected in sections 10, 17, 20; RIE, T16S, Cordova Quadrangle, Alaska--Continued

Sample No.	Thin Section Examined	Rock Description	Au ppm	Ag oz/T	Opaque Mineral	OPQ %	OPQ <=mm	CO3 %	QTZ vns <=mm	new QTZ =	Adit
Sect. 8											
NE qtr:											
3134	x	GDR, x'tls <4mm; FLD <50% alt'd; chlr'ztn	-	-	hm,apy,mag,py	1.	0.4				
NW qtr:											
3115	x	GRN, x'tls <3mm; much chlr'ztn	0.03	0.4	hm,ilm,mag	.5	.2				
Sect. 9											
NE qtr:											
3126	x	GDR, x'tls <3mm; FLD <40% alt'd; chlr'ztn	-	.2	mag,py,apy	TR	.2				
SE qtr:											
3148	x	GRN, x'tls <5mm; highly alt'd; EPD cement	.03	.2	mag,ilm,hm	3.	.4				
3186	x	HRF (from GWK)-GRN contact; 5% mafics	.05	.4	mag,hm,py	1.	.2				
3171	x	QTZ vn in SLT; pre-clvge	-	-	py,hm,mag	2.	.2		5	30	
3172	x	QTZ vn in ARG; alt'd FLD; EPD cement	.03	.1	mag,ilm,apy	2.8	.3		75		
3174		QTZ vn in ARG	TR	.2	ilm,py,hm	2.	.4		75	45	
Sect. 18											
NW qtr:											
3157	x	GRN, x'tls <3mm; FLD <60% alt'd	TR	.6	mag,hm	2.	.8				

1.5 in. range being the most common. The average mineral and element content of 18 quartz veins in graywacke and 8 quartz veins in slate are:

Materials # of spls.	OPQS (pct)	K-fld (pct)	Chlr (pct)	Au (ppm)	Ag (oz/T)	CO_3 (pct)	As (pct)
qtz vns in slt (8)	2.14	19.6	4.55(4)*	0.31	0.06	0.44(1)*	0.0
qtz vns in gwk (18)	1.71	22.1	2.58(11)*	.46	.15	2.82(6)*	0.37(8)

* Number of samples containing mineral or elements.

The persistence of dynamic stress on a more reduced scale following tectonism, while temperatures remain between 100° and 300° C (<u>31</u>), causes quartz to undergo a unique change in fracturing called the "cataclasis" (<u>10</u>). This progressive morphological change results in micro-brecciation and simultaneous recrystallization of quartz, leaving myriads of tiny new grains. Such processes produce restricted permeability within the previously impermeable quartz veins (<u>31</u>).

Cataclasis has been involved in the quartz-mineralization stage at McKinley Lake. The percentage of new quartz grains in thin sections of vein quartz was used to identify the degree to which cataclasis had progressed.

The relationship of gold mineralization to quartz veining in thirty-seven samples with predominant quartz fissure filling yielded these results:

Gold Content (ppm)	Number of samples	New Quartz (mean pct)	Opaque Minerals (mean pct)	CO_3 (mean pct)
nil	12	4.8	0.9	1.3
<0.10	14	6.6	1.3	4.1
>/=0.1	11	12.5	1.6	3.5

Although the data base is not large, gold content appears to be positively related to the amount of "new quartz" in the rock.

GEOCHEMICAL RELATIONSHIPS

The gold and other element content of the veins and different host rocks was studied to determine compositional similarities and differences.

Gold in in Graywackes and Granites

Of the 168 rock samples analyzed, 88 (52 pct) contained detectable gold and 24 (14 pct) contained at least 0.1 ppm gold (tables 5 and 6). Most high gold values occur in samples of graywackes containing quartz veinlets. Sixty-six percent of the graywacke sampled had detectable (>/=0.03 ppm) gold and of these 30 pct had significant (>/=0.10 ppm) gold (table 5). Forty percent of the granite samples contained detectable gold but only 7 pct had significant gold values.

Bedrock Geochemistry

Multi-element semiquantitative optical-emission spectrographic analyses of 168 rock samples identified elements that correlated with gold content (table 6). The average content of 15 elements present in detectable amounts in various rock types, when plotted on semilog paper (fig. 12) reveal the following relationships:

1) High gold rocks contain the highest average amount of arsenic (As). Graywacke with quartz veins and graywacke are the only other rock types with higher As content than the mean As content of all rocks analyzed.
2) High gold rocks, granite, graywacke with quartz veins, and hornfels/contact rocks contain more V, Cr, Ni, and Cu than the average for all rocks.
3) High gold rocks have elemental compositions most closely related to graywacke with quartz and hornfels than granite or slate. High-gold rocks have elemental compositions least related to slate.

FLUID INCLUSION STUDIES

Fluid inclusions in three groups of quartz veins ((1) mineralized quartz veins (>/= 0.03 ppm Au) in metasedimentary rocks, (2) barren quartz veins in metasedimentary rocks, and (3) quartz veins in granite) were studied in 17 doubly polished thick sections. One hundred sixty-eight primary-inclusion-filling and secondary-inclusion-filling temperatures were determined.

Most inclusions were simple two phase types (liquid and vapor) with 2 to 20 pct of the volume occupied by the vapor bubble. The absence of daughter minerals in the inclusions indicates moderate salinity, at most, at the time of formation (fig. 13) (24).

Table 5.--Relationship of gold values to rock-type, McKinley Lake area, Alaska.

Rock Type	Total No. of Samples	Samples w/ Au	Arithmetic Mean ppm Au	% Rock type w/ Au	% Rock w/ >/=.1/ppm Au
gwk w/qtz vns	50	33	.39	66	30
slt w/qtz vns	31	14	.14	45	6
gwk	17	8	.10	47	18
slt (arg)	23	14	.07	61	9
grn	30	12	.07	40	7
hrf/contact	17	7	.06	41	6
TOTALS	168	88			

arg - argillite

grn - granite

gwk - graywacke

hrf - hornfels

qtz vns - quartz veins

slt - slate

Table 6.--Comparisons of average element content in rock types occurring in the McKinley Lake area, Alaska.

	Graywacke w/Quartz Veins	Graywacke	Slate w/Quartz Veins	Slate	Granite	Hornfels	All Rock Samples	Gold >=0.1 ppm
	(49)	(15)	(26)	(35)	(28)	(15)	(168)	(25)
Fe	2.1570	3.100	3.577	3.857	3.107	2.200	2.977	2.620
Mg	1.1837	1.530	2.3690	2.1710	2.050	1.747	1.7984	1.460
Ca	0.8280	0.7930	1.2730	0.8710	2.4290	2.280	1.2992	0.8388
Ti	.1826	.220	0.2580	.2657	0.3054	0.2421	0.2407	.1999
As	.1224	.080**	--	.0029*	--	--	.0435	.1720
Ba	.0559	.0830	.0646	.0743	.0579	.0567	.0639	.0704
Mn	.0296	.0330	.0469	.0486	.055	.0640	.0438	.0456
Sr	.0098	.004*	.0046**	.0017*	.0021*	.0133	.00582	.0120
V	.0047	.0104	.0091	.0124	.0046	.0044	.00745	.0068
Cr	.0034	.0049	.0052	.0051	.0014	.0021	.00372	.0034
Ni	.0018	.0034	.004	.0033	.0019	.0016	.0026	.0021
Cu	.0016	.0057	.0088	.0122	.0007	.0023	.0052	.0019
Zn	.0018	.0043	.0006	.00097	.0023	.00170	.00174	.0016
B	.0007	.0017	.0011	.0021	.0005	--	.00105	.0012
Ga	.0008	.0015	.0015	.0016	.0020	.0016	.0014	.0011

* one value
** two values

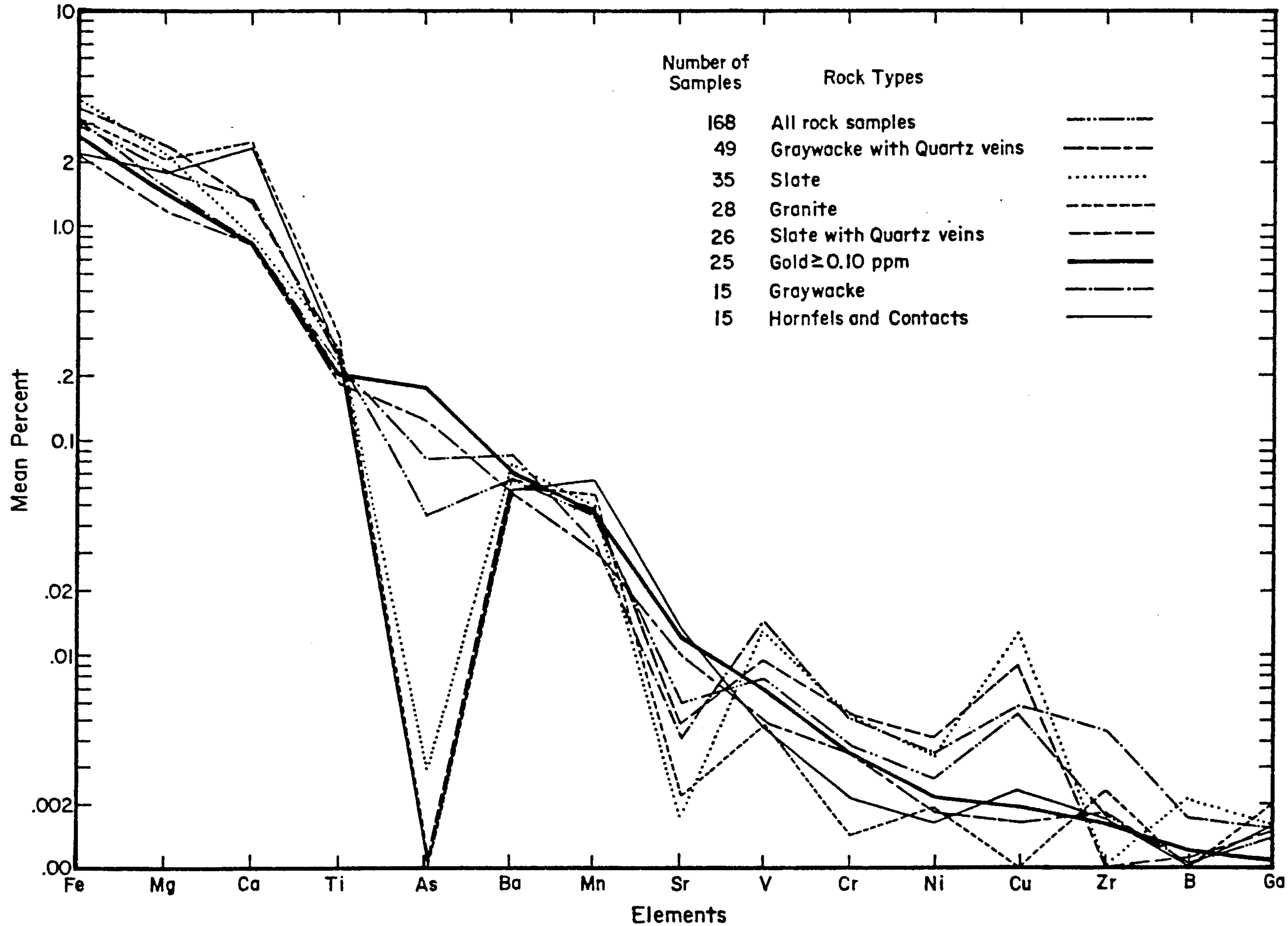


Figure 12.--Comparison of averaged element content of rock types from the McKinley Lake area, Alaska.

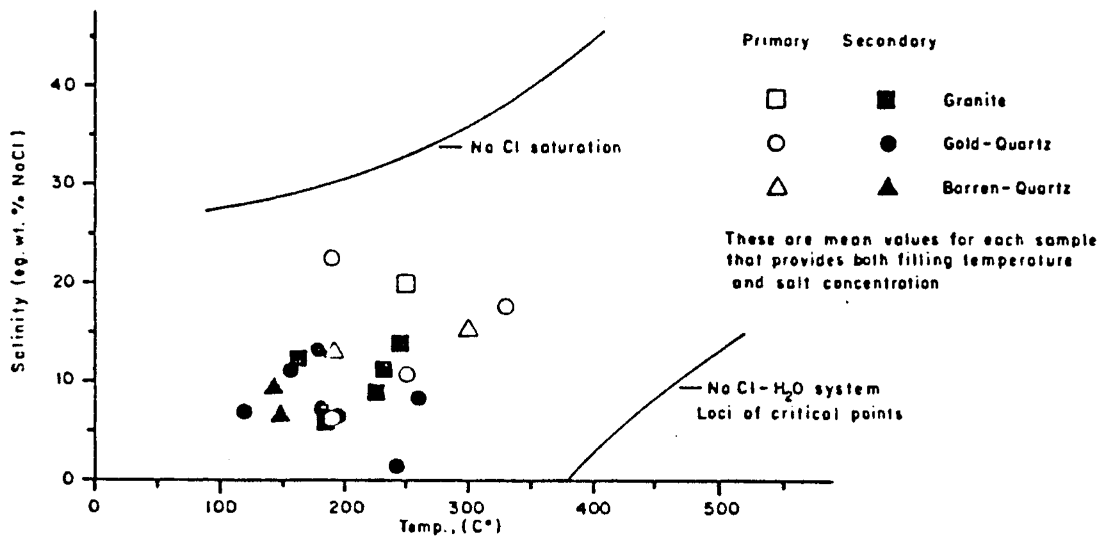


Figure 13.--Fluid inclusion salinity and filling temperature relationships of quartz from McKinley Lake area, Alaska samples.

The homogenization and primary-inclusion-filling temperatures of the mineralized and barren quartz veins in metasedimentary rocks ranged from 180° to 410° C, and averaged about 300° C. Homogenization data for quartz veins in granite indicate that primary-inclusion-filling temperatures were greater than 250° C (fig. 14). The upper homogenization limit was not observed due to the tendency of vein quartz from granite to become opaque with increasing temperature, thus masking the end point. The secondary-inclusion-filling temperatures of quartz in all three rock types ranged between 107° and 267° C.

Differences Between Quartz Types

Differences in salinities of fluid inclusions in quartz in the various rock types may be more readily observed when the frequency distribution of salinites as determined by depression of freezing point, is shown in a histogram (fig. 15). The primary fluids in mineralized quartz are more saline than those in barren quartz. The bimodal salinity distribution in mineralized and barren veins suggests two primary fluid phases.

The secondary fluid inclusions in quartz in granite have a unimodal salinity distribution. Secondary inclusions in mineralized quartz also have unimodal salinity distribution but it is of lower average value with the values skewed toward the peak frequency of secondary-fluid-inclusion salinites of granites. The spread of salinity values of mineralized quartz remains wide enough to encompass the secondary-fluid-inclusion salinity ranges of both other quartz types. The salinity-concentration frequencies of secondary inclusions in barren quartz have an evenly balanced bimodal distribution.

Primary vapor-rich and liquid-rich inclusions occurring together in quartz without evidence of necking down are found in granite sample 3147. Assuming a hyrdologically open system, this infers an emplacement depth of 1,200±50 ft for this granite pluton (11). The resultant pressure of 36±1 bars is low enough that the pressure correction, less than 6°C for even the most affected combination of salinity and temperature encountered in all the samples studied (24), is not significant compared to the range of temperatures measured, and so has not been applied.

In summary, the paucity of usable fluid inclusion data for quartz veins makes comparisons less than definitive but the following observations appear relevant:

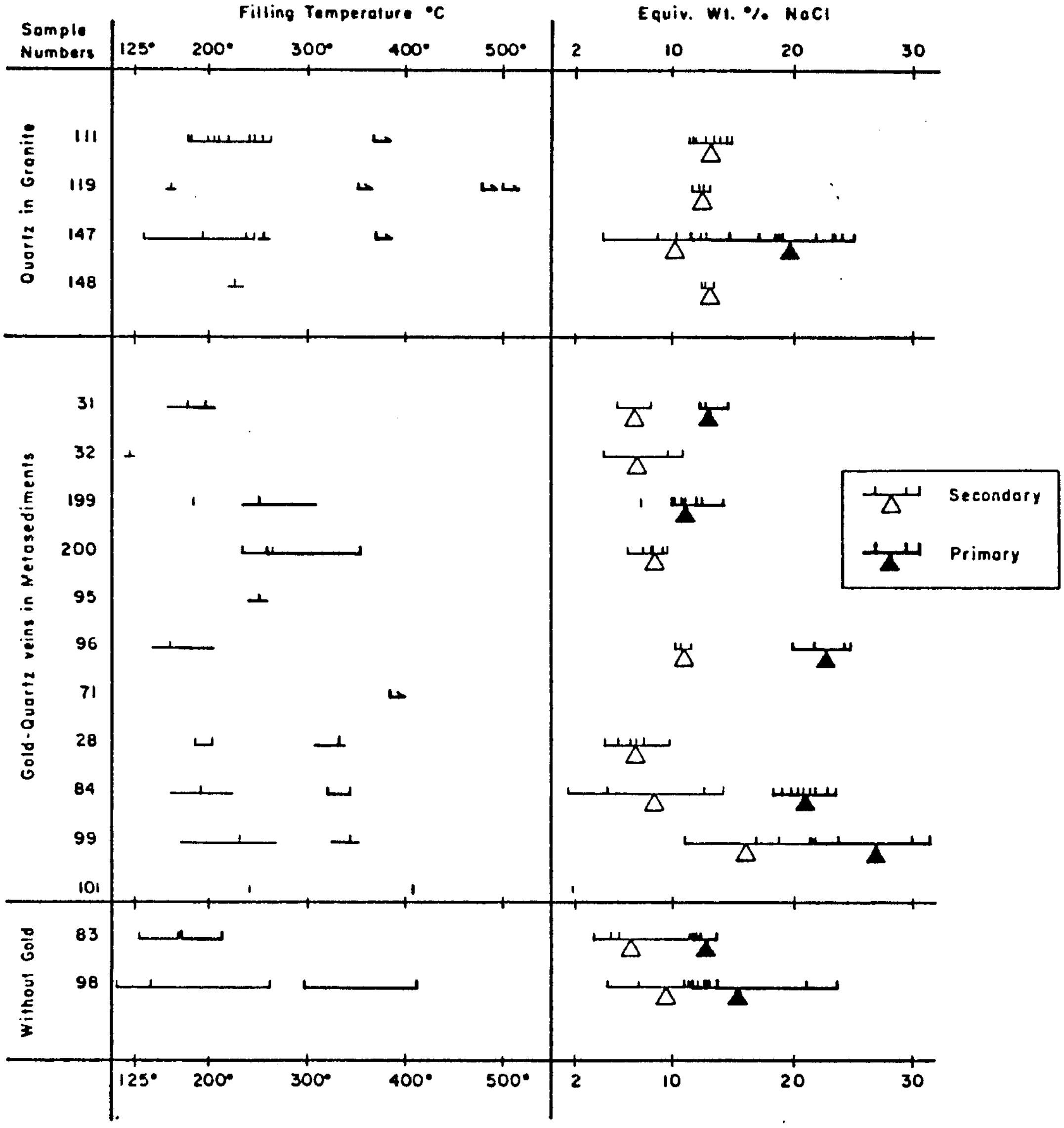


Figure 14.--Temperature and salinity ranges of fluid inclusion of quartz from three rock types from McKinley Lake area, Alaska.

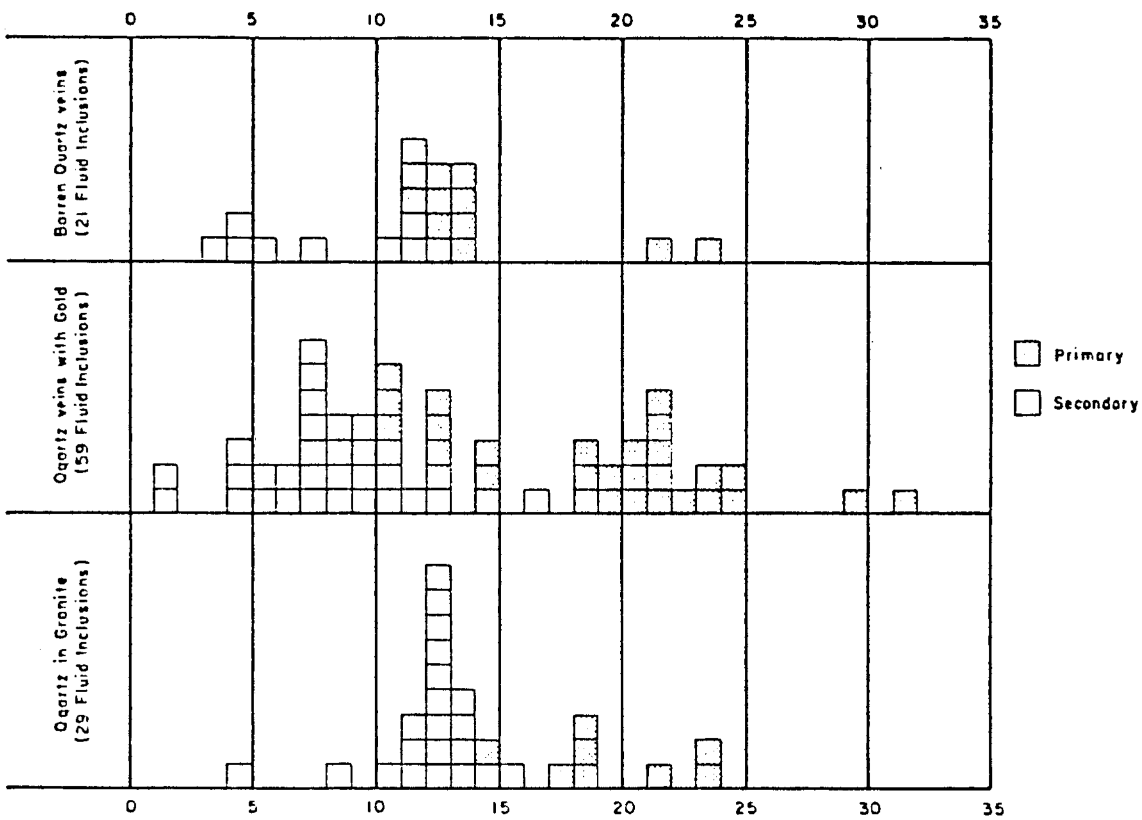


Figure 15.--Frequency distribution of equivalent weight percent NaCl in primary and secondary fluid inclusions in quartz from three rock types, McKinley Lake area, Alaska.

1) At least two primary fluids contributed to quartz vein formation in the metasedimentary rocks, and possibly the intrusive body as well. The possibility of one fluid which has evolved over distance traveled is less probable.

2) Several secondary fluid inclusion populations were identified in the filling of quartz systems outside the granite, suggesting several fluids were involved.

3) The data indicate only a secondary fluid was present in quartz in the granite pluton.

4) The overall similarity of fluid inclusions in all rock types suggests post-intrusion mineralization of the area.

DISCUSSION OF RESULTS

Gold occurs more commonly with quartz veins in graywackes than in slates; but gold is also present in quartz in granitic rocks. The relationship of the granitic pluton to the surrounding rocks is one of forceful emplacement and it could have been a source for mineralizing fluids. Fluid-inclusion data and vein mineralogy suggest that the gold mineralization is post intrusive. Hydrothermal emanations from greater depth are the likely sources for most of this gold.

GOLD OCCURRENCES

The grouping of vein gold occurrences by rock type shows that graywacke with quartz veinlets contains gold more frequently as well as in largest average amounts.

Quartz veining in graywacke is most abundant in fold hinges. Although the quartz stringers are generally not continuous beyond the graywacke beds, the clustering of these veins in the fold hinges could provide continuous fluid channel systems over distances comparable to the area of folding.

The quartz veinlets and lenses are less common in slate than in graywacke and they tend to occur singly rather than in clusters. The veinlets in slate are usually narrower than those in graywacke (average quartz vein widths: slate - 0.5 in.; graywacke - 2 in.). The quartz stringers and lenses which parallel bedding foliation in slate are believed to have formed during the later phases of dehydration and metamorphism of the original pelitic sediments, as a result of burial depth (thermal gradient) and overburden pressure.

SOURCES OF GOLD

The major rock types in the McKinley Peak study area are relatively impermeable and fluid transport could occur only after fracturing had taken place.

The tectonic forces that produced the isoclinal folding and thrust faulting had been largely dissipated by the time the pluton approached its present location from greater depth. During the emplacement of the pluton, at a calculated depth of slightly more than 1,000 ft, the temperature of this granitic body along the contact is estimated at 500°C. Derivation of this temperature is from Winkler's (32) figures for a 700°C granitic magma emplaced at a depth of 1 km and it correlates well with the petrology of the contact rocks: the chlorite-zone metapelites were thermally metamorphosed to the albite-epidote hornfels facies (32).

The tendency for bedding to become more parallel with the borders of the pluton as the contact is approached suggests a forceful emplacement (16). Although the contact of the pluton is parallel with most local structures, it does cut at least two sets of major lineations which could have allowed hydrothermal fluids to escape. Furthermore, because thrust faults and axial fold planes dip toward the pluton, additional avenues of pressure release from granitic melt were probable. Upon encountering the faults and fold fractures, solutions could have migrated along them and subsequently minerals formed from them until the plumbing systems became filled.

The megascopic lineations which occur within the granitic body itself also could represent avenues for fluid escape. They are also seen to have formed in response to stresses applied after crystallization. Gold is detected in samples from areas of two of these lineations. This suggests an additional fluid source, perhaps from another pluton at greater depth.

Initially, the metamorphosed rocks were sealed by silica-bearing fluids. Subsequent cataclasis of quartz opened small fractures allowing later gold-bearing solutions to impregnate the entire system, providing a diffuse, disseminated gold content in a large volume of rock.

CONCLUSIONS

Economic gold-bearing zones were not located during field work, nor were economic gold concentration found in any of the samples analyzed. However, 52 pct of the 168 rock samples collected contained "detectable" gold, >/= 0.03

ppm. The average gold concentration of all rock samples containing gold is 0.18 ppm. Gold is widely disseminated but in very low concentrations in all major rock types. The gold mineralization was emplaced after the intrusion of the pluton into metasedimentary rocks.

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