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Potential for Lode Deposits in the Livengood Gold Placer District East-Central Alaska

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By R. L. Foster

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CONTENTS

ILLUSTRATIONS

TABLES

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By R. L. Foster

Abstract

The Livengood gold placer district of east-central Alaska contains small bedrock deposits that probably were the source of the placer gold. Stream sediments in parts of the district, particularly in the Ruth Creek drainage, are characterized by abnormally high concentrations of gold, arsenic, mercury, antimony, molybdenum, and silver, and Ruth Creek itself is characterized by highly acid water. The area is complex geologically and is cut by many thrust faults, some of which have been invaded by serpentinite. Ruth Creek and some of the other geochemically anomalous areas are in upper plate clastic rocks that may be underlain by siliceous carbonate rocks beneath thrust faults. The small lode deposits in the upper plate rocks may represent leakage anomalies above economically significant metal deposits in rocks in or below the thrust fault zones.

INTRODUCTION

The Livengood district is in the Yukon-Tanana upland, approximately 80 road miles northwest of Fairbanks (fig. 1). It is accessible during the summer and fall via State Highway No. 2, an improved dirt and gravel road, and accessible during the entire year by fixed-wing aircraft.

Gold placers of the Livengood district have produced approximately 380,000 fine ounces of gold from stream and bench placer deposits (Cobb, 1964), distributed approximately as shown in figure 2. Production has come from nonfloat placer operations, dredging, and drift mining. The major production was derived from the Livengood Creek area, Olive Creek, Lillian Creek, Ruth Creek, Amy Creek, and the Gertrude Creek area. There are at present active nonfloat gold placer operations on Livengood Creek and Amy Creek, but only sporadic mining activity on Ruth, Lillian, and Olive Creeks.

Small veins and areas of mineralized rock have been prospected in several places, as shown in figure 2, but mineral production from the bedrock deposits has been negligible.

Field investigations were carried out during the summer of 1967 as part of the Heavy Metals program of the U.S. Geological Survey and included geologic mapping, sampling of geologic materials, and evaluation of prospects. Sediment samples were collected chiefly from flowing streams and springs; some were collected from the dry beds of intermittent streams. The sediment samples were dried and sieved and the minus 80-mesh fraction analyzed by atomic absorption for gold, by spectrograph for about 30 elements, and by a specific atomic-absorption-type instrument for mercury. Bedrock samples were analyzed by the same methods, and a few samples of both rock and stream sediment materials were analyzed for gold by fire assay to check the atomic-absorption results.

GEOLOGIC ENVIRONMENT

The southern two-thirds of the Livengood district is underlain chiefly by a metamorphosed clastic facies of sedimentary rocks, the northern one-third, by a chert-carbonate facies. These facies are separated by an eastward-trending belt of serpentinites (fig. 1). The serpentinites and associated rocks are considered to have been emplaced originally along major fault zones after or concurrently with diorite intrusion at Amy Dome. The metadiorite at Amy Dome is not believed to be associated with any metallization. Much later, probably in Tertiary time, plugs which range in composition from quartz monzonite to monzonite were intruded, and it is with these rocks that the mineral deposits of the district are associated.

The clastic facies consists chiefly of fossiliferous graywacke and argillite strata of Devonian age and similar lithologies of questionable Devonian age south of the Tolovana River and east of Cleary Creek, together with quartzite, chert-pebble conglomerate, and minor carbonate beds. Serpentinite with tectonic inclusions is spatially associated with this facies (Foster, 1967). Rocks commonly associated in turn with the serpentinites are metadiorite, metabasalt, peridotite, and silica-carbonate-talc rocks formed by the hydrothermal alteration of ultramafic rocks. Metadiorite is limited to the Amy Dome area and several places within the serpentinites. The chert-carbonate facies exposed in the northern part of the district consists chiefly of siliceous dolomite, black chert, black and gray banded chert, chert breccia, volcaniclastic and tuffaceous beds, and massive mafic igneous rocks of probable pre-late Middle Devonian age. The Tertiary(?) quartz monzonite and monzonite occur chiefly as small discordant intrusives in the west-central part of the area.

The serpentinites form an eastward- to northeastward-trending complex belt of outcrops which extends beyond the boundaries of the district (Foster, 1967). The serpentinites are believed to have been emplaced originally as subhorizontal sheets associated with regional thrust faults, much as suggested by Irwin (1964) for the Klamath Mountains and Coast Ranges of northwestern California and southwestern Oregon. Their present outcrop pattern however is believed to reflect subsequent upward dragging along high-angle reverse faults; this interpretation is supported by the generally straight-line trend of the outcrops and by the apparent absence in the adjacent rocks of mineral or textural zonation such as reported by Blake, Irwin, and Coleman (1967) below the sole of a major thrust fault in northwestern California along which ultramafic rocks have been emplaced.

The clastic facies is interpreted as overlying the serpentinite complex, and the chert-carbonate facies as underlying the complex. The serpentinite complex has been the locus of repeated faulting and consequently its contacts in many places are faults, as shown in figure 1.

Monzonitic plugs occur along a northwest-trending lineament that cuts the clastic facies and is thought to cut both the serpentinite complex and the chert-carbonate facies.

ECONOMIC GEOLOGY

Lode deposits

The small lode gold deposits known in the Livengood district (fig. 2) are in siliceous graywacke near Lillian, Olive, and Ruth Creeks, in altered breccias on Ruth Creek, and in silica-carbonate rock on Gertrude Creek and at the Griffin prospect. These deposits are spatially related to monzonitic stocks and dikes of probable Tertiary age (fig. 1). Brief descriptions of the deposits follow; the numbers refer to locations shown in figure 2.

(1) Gertrude Creek prospect.—Massive, iron-stained silica-carbonate rock, which is green on fresh surfaces, contains minor amounts of gold (sample No. 21, table 2).

(2) Ruth Creek prospect.—Pyritized, brecciated, iron-stained igneous rock shows replacement by silica and carbonate and contais traces of gold (sample Nos. 20 and 23–29, table 2).

(3) Lillian Creek prospect.—Narrow auriferous arsenopyrite-quartz-scorodite veins occur in and near a limonite-stained dike in altered and contorted graywacke-argillite country rock. Samples from the prospect contain from 0.5 to 48 ppm gold (sample Nos. 1–11 and 22, table 2).

(4) Griffin prospect.—Massive, sulfide-bearing, green-stained silica-carbonate-talc rock veined by quartz contains as much as 3.9 ppm (parts per million) gold (sample Nos. 16–17, table 2).

(5) Old Smoky prospect.—Narrow, northwestward-trending auriferous arsenopyrite-quartz veins occur in a ferruginous quartzite footwall near the intersection of an altered porphyritic biotite monzonite dike and a potassium feldspar-rich porphyry dike. Samples from the prospect contain from 3 to 13 ppm gold (sample Nos. 12–15, table 2.)

(6) Sunshine No. 2 prospect.—A northwestward-trending, crumbly, auriferous dike with internal limonite veinlets is in contact with altered argillite. Recent work is a few hundred feet above two caved adits and an arrastre at the Hudson mercury prospect. Cinnabar nuggets were abundant in the heavy mineral concentrates from a cleanup made in August 1967 at the Olive Creek gold placer.

Sketch maps, sample locations, and chemical analyses from the Lillian Creek, Old Smoky, Sunshine No. 2, Ruth Creek, and Griffin prospects, together with data from soil samples collected during prospect evaluation, are available in a U.S. Geological Survey open-file report (Foster, 1968). These data and other investigations (Foster and Chapman, 1967) indicate that the known gold lode deposits of the Livengood area are economically unattractive owing to their limited tonnages and(or) low grade. They may be significant, nevertheless, in that they suggest the possibility of concealed deposits in this seemingly favorable lithic and structural setting.

Geochemical Investigations

Geologic studies, rock analyses, and reconnaissance stream-sediment investigation have revealed a large polymetallic anomaly near Ruth Creek and several minor anomalies, including a gold anomaly, near Lucille Creek (fig. 3).

The Ruth Creek anomaly (fig. 3, localities 42–47 inclusive) is characterized by above-background concentrations of gold, arsenic, mercury, antimony, molybdenum, silver, and boron in stream sediments (sample Nos. 42–47, table 1). Small sulfide veins, fracture coatings, disseminations, and replacement deposits (field Nos. 2–6, table 2) near small monzonitic stocks and dikes (field Nos. 1–3, table 3) contain anomalous concentrations some of these elements, which account, at least in part, for their presence in stream sediments down drainage. The anomalous zinc concentrations on table 1 (sample Nos. 47, 48) may be real but are suspect because the samples were collected downstream from galvanized culverts.

The presence of sulfidized rocks is also indicated by acid metalliferous water in Ruth Creek. The water is red from suspended oxidized iron compounds, although the ground water discharging into Ruth Creek is clear. The pH determined in the field on four samples ranged from 3.0 to 5.0; a laboratory determination on one sample gave a pH of about 2.75. The chemical composition of the stream water (table on page 3) shows that at least some of the water has been in contact with various sulfides or sulfosalts other than pyrite.

Other anomalous areas include those in the Olive Creek drainage, Alder Gulch area, and near Lucille Creek.

A sample from the left tributary of Alder Gulch (sample No. 40, table 1) contains anomalous amounts of lead and mercury, which are attributed to mineralization along or near the major east-trending fault inferred to underlie the headwater area of this drainage basin (fig. 1).

The anomalously high gold content in stream-sediment samples from Fanny Gulch (sample No. 9, table 1) and Lucille Creek (Sample No. 20, lab. No. ACE–419, table 1) suggests gold metallization in the chert-carbonate terrane, whereas the strongly anomalous gold values in panned concentrates from Lucille Creek (sample No. 20, lab. Nos. ACE–486,–488,–490, table 1) indicate the possible presence of a small gold placer deposit.

The significance of anomalous amounts of manganese and antimony in a sample collected in the Franklin Creek drainage (sample No. 23, table 1) is unassessed; these anomalies may be related to the presence of mafic igneous rocks and massive chert-carbonate strata.

CONCLUSIONS AND RECOMMENDATIONS

The combination of minor lode deposits, geochemical anomaly, and structural pattern at Ruth Creek makes this area worthy of further investigation as a potential exploration target. Dip of the faults in the area is a critical factor. If the faults near Livengood (figs. 1, 4A) are low-angle thrusts dipping south, a footwall section of chert-carbonate rocks may exist at shallow depth. The siliceous dolomite and contorted or fractured chert in such a section are considered favorable host rocks for gold deposition. If the minor lode deposits in the Ruth Creek area represent leakage over a mineralized zone, the chert-carbonate rocks, as well as some of the rocks in the fault zone would be logical targets for physical exploration. On the other hand, if the faults are high-angle reverse or strike-slip in nature (fig. 4B), then the favorable chert-carbonate strata may be buried at too great a depth to be a practicable target.

Analysis of Ruth Creek water

[Analyst: R. B. Barnes]

Constituent	Concentration (ppm)	Constituent	Concentration (ppm)
SiO_2	19	Sr	0.6
Al	25	Ba	<.05
Fe (total)	106	Na	6
Mn	30	K	2
Zn	5.2	NH_4	.3
Cu	.1	SO_4	986
As	1	Cl	.4
Ca	76	B	.7
Mg	92		

It is interesting that the geologic setting and geochemical suite of anomalous metals (arsenic, mercury, and antimony in particular) are similar to the setting and suite known to be favorable for the occurrence of Carlin-type gold deposits in north-central Nevada (Roberts, 1960, 1966; Hardie, 1966; Erickson and others, 1966). However, the significance of these apparent similarities in not known.

Geophysical investigations and more detailed geologic studies would be a logical first step in determining the dip of the faults, but ultimately drilling would be required. If the information gained from an investigation of the Ruth Creek anomaly indicates economic mineralization associated with thrust sheets cut by Tertiary(?) intrusive rocks, then a search for similar geologic environments along the Livengood trend is suggested. Both the anomalous metal concentrations in the fault-zone metasomatites and the silica-carbonate-talc rocks themselves are indicative of hydrothermal activity within and along the postulated major faults in the vicinity of the monzonitic rocks.

The silica-carbonate-talc rocks derived from the serpentinites are considered favorable hosts. Their low magnetic susceptibility, due to the oxidation of primary and secondary magnetite during hydrothermal alteration, contrasts sharply with that of the serpentinites. Thus, magnetometer surveys along and on strike with highly magnetic serpentinites might reveal the presence of silica-carbonate-talc rocks which could provide additional exploration targets.

The available data suggest that the Livengood Creek gold placer deposits represent a sizeable gold resource which warrants additional economic appraisal. Information from 640 drill holes in the gravels of the Livengood Creek area indicates some 17 million cubic yards of material with an average recoverable gold content of about 70 cents per cubic yard (gold at $35 per ounce) (C. F. Herbert, written commun., 1966). The Lucille Creek gold placer deposit found during this study also should be investigated further, although the thick overburden and lack of water might make this deposit uneconomic.

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TABLES 1–3 AND FIGURES 1–4

Table 1.--Semiquantitative spectrographic analyses and other analyses for gold

[Looked for but not detected: Bi, Cd, Pt, Pd, Rh, Sc, Sn, Ta, Te. Symbols used: <, less than; detectability. Spectrographic analyses by D. J. Grimes; results are reported to the nearest sorption by A. L. Meier, R. L. Miller, and T. A. Roemer. Mercury analyzed by instrumental are given in percent. pH, field determination; sample 42 includes laboratory determination

Sample No.	Lab. No.	Field No.	Ag	As	Au Spectro-graphic	Au Atomic Absorp-tion	B	Ba	Be	Co	Cr	Cu	Hg	La
1	ACE-508	1	A	A(200)	A(10)	<0.02	15	500	<1	20	100	30	0.85	20
2	217	2	A	A	A	<.1	15	700	<1	10	100	20	.36	20
3	423	3	A	A	A	<.02	15	500	A	15	1,500	30	.30	A
4	425	4	A	A	A	<.02	10	300	<1	7	30	30	.20	20
5	426	5	A	A	A	<.02	15	700	<1	15	500	30	.50	<20
6	428	6	A	A	A	<.02	20	1,000	1	10	70	30	.13	30
7	429	7	A	A	A	<.1	15	500	1	A	15	30	.18	<20
8	427	8	A	A	A	<.02	20	700	<1	15	300	20	.30	20
9	434	9	A	A	A	10.5	20	300	A	20	2,000	30	---	>20
10	433	10	A	A	A	<.02	20	500	<1	10	150	30	.16	20
11	437	11	A	A	A	<.02	10	300	A	30	1,000	30	.34	A
12	436	12	A	A	A	<.02	15	300	A	15	700	30	.26	A
13	438	13	A	A	A	<.1	15	200	<1	30	1,500	30	.38	A
14	447	14	A	A	A	<.1	20	200	1	5	50	30	.30	<20
15	446	15	A	A	A	<.02	15	300	A	30	3,000	30	.26	A
16	441	16	A	A	A	<.02	10	300	A	30	2,000	30	.12	A
17	440	17	A	A	A	<.1	15	200	A	30	1,500	30	.52	A
18	439	18	A	A	A	<.02	15	300	A	20	1,500	30	.12	A
19	417	19	A	A	A	<.02	<10	500	A	10	70	30	.08	A
20	419	20	A	A	A	2.3	15	500	A	10	100	20	.10	20
21	420	21	A	A	A	<.02	15	700	<1	15	700	30	.60	<20
22	421	22	A	A	A	<.02	10	300	A	5	50	15	.08	A
23	200	23	A	A	A	<.02	15	500	A	7	50	30	.14	A
24	405	24	A	A	A	<.02	20	500	A	10	700	30	.11	30
25	404	25	A	A	A	<.02	10	300	A	15	300	20	.11	A
26	478	26	A	A	A	<.02	15	500	<1	15	70	15	.20	20
27	477	27	A	A	A	<.02	15	500	<1	10	70	30	.07	20
28	476	28	A	A	A	<.1	15	300	<1	20	300	30	.07	<20
29	403	29	A	A	A	<.02	15	500	A	15	300	20	.06	20
30	402	30	A	A	A	<.02	15	300	A	20	700	20	.05	A
31	401	31	A	A	A	<.02	20	300	A	30	700	20	.07	A
32	400	32	A	A	A	<.02	15	500	A	20	500	20	.08	<20
33	069	33	A	A	A	---	10	300	<1	7	50	20	.22	<20
34	384	34	A	A	A	<.02	10	1,000	<1	15	300	50	.13	A
35	386	35	A	A	A	<.02	20	1,000	A	10	300	30	.12	A
36	385	36	A	A	A	<.02	15	500	A	30	700	30	.10	A
37	382	37	A	A	A	<.02	10	500	A	7	70	15	.08	20
38	381	38	A	A	A	<.02	15	500	A	50	2,000	20	.10	A
39	380	39	A	A	A	<.02	10	500	A	50	1,000	20	.07	A
40	379	40	A	A	A	<.02	10	300	A	50	2,000	30	.85	<20
41	522	41	A	A	A	<.02	20	1,000	<1	10	70	30	.60	20
42	103	42	A	300	A	<.02	70	700	2	7	70	30	.26	30
43	114	43	A	300	A	<.02	70	700	2	7	70	30	.18	50
44	118	44	A	200	A	.5	50	500	<1	15	150	20	.20	20
45	119	45	5	700	A	.2	70	700	1	15	150	30	.20	30
46	265	46	A	300	A	2.0	100	500	<1	15	200	20	---	20
47	330	47	.5	2,000	<10	8.2	150	1,000	1.5	10	200	50	1.4	50
48	461	48	<.5	700	A	<.02	70	1,000	1.5	15	300	30	1.3	30
49	089	49	A	200	A	---	30	700	1	20	200	30	.60	20
50	088	50	A	<200	A	---	30	500	1	15	150	30	1.2	20

>, greater than; A, not detected; ---, not looked for; I, interference; (200), lower limit of number in the series 1, 0.7, 0.5, 0.3, 0.2, 0.15, 0.1, and so on. Gold analyzed by atomic ab- method by S. L. Noble. Results are given in parts per million except for Mg, Fe, Ca, Ti, which also, as indicated by an asterisk. Field numbers are shown in figure 3]

Mo	Mn	Nb	Ni	Pb	Sb	Sr	V	W	Y	Zn	Zr	Mg	Fe	Ca	Ti	pH
A(5)	700	10	30	10	A(100)	150	70	A	15	A	300	0.7	3	1	0.7	6.0
A	300	A	30	10	A	150	70	A	15	A	100	.7	2	1	.3	6.5-7.0
A	500	A	150	<10	A	150	100	A	15	A	150	1.5	3	1	.3	6.0
A	300	A	15	30	A	70	50	A	10	A	70	1.5	1.5	3	.3	6.5
A	500	A	70	15	A	150	70	A	10	A	70	1.5	2	.7	.3	6.0
A	300	<10	30	<10	A	150	70	A	15	A	200	.7	2	1	.5	6.0
A	70	A	7	10	A	<50	70	A	7	A	70	.15	.7	.2	.2	5.0
A	500	<10	150	<10	A	150	70	A	15	A	100	1.5	2	1	.3	6.0
A	300	A	200	<10	A	70	70	A	10	A	70	1.5	2	1	.3	6.0(?)
A	300	A	30	<10	A	150	70	A	15	A	70	.7	2	1	.3	---
A	500	A	150	<10	A	70	70	A	15	A	70	1.5	2	1	.3	6.5
A	500	<10	150	<10	A	70	70	A	10	A	70	1.5	1.5	1	.3	6.0
A	700	A	200	<10	A	50	70	A	10	A	50	1.5	2	.7	.3	6.0
A	500	A	20	<10	A	<50	70	A	10	A	70	.3	.7	.7	.2	5.5
A	500	A	300	<10	A	50	70	A	10	A	70	1.5	2	.7	.2	6.0
A	700	A	300	<10	A	70	70	A	7	A	70	2	2	1	.2	6.0
A	500	A	150	<10	A	70	70	A	10	A	50	2	3	1	.3	6.0
A	500	A	150	10	A	100	70	A	10	A	100	1.5	2	1	.5	6.0
A	300	A	30	15	A	100	70	A	15	A	70	1.5	1.5	1.5	.3	6.5-7.0
A	300	<10	30	15	A	150	70	A	15	A	70	1.5	1.5	1.5	.3	6.5-7.0
A	500	<10	100	<10	A	100	100	A	15	A	300	.7	3	.7	.7	---
A	300	A	10	<10	A	70	70	A	15	A	150	.5	1.5	1	.3	6.5-7.0
A	1,000	A	15	<10	150	100	30	A	10	A	70	.7	1.5	1	.3	6.0
A	500	A	70	10	A	150	70	A	15	A	100	1.5	2	1	.3	6.0
A	300	A	70	10	A	150	70	A	15	A	100	1.5	1.5	1.5	.3	6.0
A	500	<10	30	40	A	150	70	A	15	A	200	.7	2	1.5	.3	6.5-7.0
A	500	<10	30	15	A	100	70	A	15	A	150	.7	1.5	1	.3	5.5
A	700	<10	150	<10	A	70	70	A	15	A	70	1	2	1	.3	5.5
A	500	<10	100	<10	A	150	70	A	15	A	150	1	2	.7	.3	6.0
A	500	A	200	15	A	150	70	A	15	A	70	1	2	.7	.3	6.0
A	700	A	150	<10	A	70	70	A	15	A	50	1	2	.5	.3	6.0
A	300	A	150	<10	A	100	70	A	15	A	150	1	2	.5	.3	6.0
A	300	<10	30	<10	A	70	70	A	10	A	70	.5	2	1	.3	6.0
A	300	A	70	<10	A	100	100	A	15	A	100	.7	1.5	.7	.3	---
A	300	A	70	<10	A	150	70	A	15	A	200	1	2	1	.5	---
A	700	A	200	10	A	100	70	A	10	A	100	1.5	1.5	.3	.3	6.0
A	300	<10	20	10	A	100	70	A	10	A	150	.5	1.5	.7	.3	6.0
A	700	A	700	<10	A	100	70	A	10	A	100	2	3	.5	.3	6.0-6.5
A	500	A	500	<10	A	150	70	A	7	A	70	2	2	.3	.3	6.0
A	500	A	500	100	A	100	70	A	10	A	100	2	2	.7	.3	6.5
A	700	<10	30	<10	A	70	100	A	15	A	100	.3	2	.7	.3	---
5	100	30	50	10	<100	70	70	A	15	A	300	.3	2	.05	.3	3.5(2.75)*
7	100	30	50	15	100	70	100	A	20	A	300	.3	.3	.05	.3	3.0
A	300	<10	70	<10	A	100	70	A	10	A	70	.3	2	.2	.3	5.0
5	200	10	70	15	A	100	100	A	15	A	100	.3	3	.1	.3	4.5
A	700	A	70	10	100	100	70	A	15	A	150	0.7	1.5	0.5	0.3	---
10	150	A	70	30	200	150	100	<50	20	500	100	.5	3	.1	.2	---
7	500	10	100	15	A	100	100	A	15	300	150	.5	2	.2	.3	6.0
<5	300	<10	150	15	A	150	150	A	15	<200	70	.5	3	.07	.3	5.5
A	300	<10	70	15	A	70	100	A	10	<200	70	.3	2	.15	.3	6.0

Table 1.--Semiquantitative spectrographic analyses and other analyses for gold and

Sample No.	Lab. No.	Field No.	Ag	As	Au Spectro-graphic	Au Atomic Absorp-tion	B	Ba	Be	Co	Cr	Cu	Hg	La
51	ACE-082	51	A	200	A	---	30	300	1	15	150	30	.70	20
52	526	52	<.5	A	A	<.02	70	700	1	20	150	50	.85	50
53	090	53	A	A	A	---	30	300	<1	30	1,000	30	.30	<20
54	182	54	A	A	A	<.02	20	500	<1	20	300	30	.55	A
55	135	55	.7	A	A	<.02	<10	150	<1	7	50	30	.20	A
56	129	56	7	A	A	<.02	15	150	A	100	700	30	.15	A
57	120	57	.7	A	A	<.02	30	150	<1	30	150	30	.18	A
58	128	58	A	A	A	<.02	15	500	<1	15	150	15	.50	<20
1/ 20	486	20				60								
1/ 20	488	20				112								
1/ 20	490	20				36								

1/ Panned concentrate.

mercury of stream- and spring-sediment samples from the Livengood district--Continued

Mo	Mn	Nb	Ni	Pb	Sb	Sr	V	W	Y	Zn	Zr	Mg	Fe	Ca	Ti	pH
A	500	<10	100	15	A	50	100	A	10	<200	70	.7	3	.15	.2	6.0
<5	500	10	100	150	A	100	100	A	15	200	100	.5	3	.3	.3	---
A	500	<10	300	10	A	70	70	A	15	A	70	1.5	3	.7	.3	6.0
A	500	<10	150	15	A	70	50	A	15	A	70	1	2	.3	.3	---
A	300	A	30	<10	A	<50	70	A	10	A	30	.5	1.5	.7	.2	---
A	500	A	150	<10	A	150	150	A	10	A	30	2	3	1.5	.3	---
A	700	<10	70	<10	A	50	70	A	10	A	70	.7	3	.3	.3	6.0
A	1,000	<10	30	<10	A	70	70	A	10	A	70	.3	2	.7	.2	6.0

Table 2.--Semiquantitative spectrographic analyses and gold

[Looked for but not detected: Bi, Cd, Hg, Pt, Pd, Rh, Sc, Sn, Ta, Te. Symbols used:<, less ference; (10), lower limit of detectability. Spectrographic analyses by Arnold Farley, Jr., 0.3, 0.2, 0.15, 0.1, and so on. Gold analyzed by atomic absorption by A. L. Meier, R. L. Yager. Results are given in parts per million except for Mg, Fe, Ca, Ti, which are given

Sample No.	Lab. No.	Field No.	Ag	As	Au			B	Ba	Be	Co	Cr	Cu
					Spectro- graphic	Atomic absorp- tion	Fire assay						
1	ACE-220	3	1.5	>10,000	A(10)	4.0	13	150	1,000	5	A(5)	70	150
2	221	3	.5	G	A	3.5	3	100	700	5	A	10	200
3	224	3	1.5	G	10	30	39	100	500	1.5	A	50	300
4	225	3	1.5	G	10	23	21	30	300	2	A	20	200
5	226	3	2	G	<10	48	44	300	500	2	A	50	500
6	227	3	1.5	G	15	20	26	100	200	1.5	A	20	300
7	228	3	1.5	G	15	25	47	70	150	1.5	7	10	500
8	230	3	.5	G	A	1.3	1.4	<10	150	1.5	10	5	15
9	232	3	A(.5)	G	A	1.4	---	70	50	<1	50	<5	10
10	234	3	2	10,000	A	0.7	---	500	1,000	3	20	30	150
11	235	3	1.5	3,000	A	0.5	---	200	1,500	3	30	50	100
12	343	5	A	>10,000	A	7.3	1.6	150	150	2	10	200	50
13	344	5	A	G	A	13	7.0	100	50	2	20	20	100
14	345	5	A	G	A	3	4.6	100	100	2	7	50	15
15	346	5	.5	G	<10	3	3.8	300	150	3	5	30	500
16	349	4	A	1,500	A	1.3	---	<10	30	<1	50	1,000	2
17	350	4	.5	>10,000	A	3.9	5.6	<10	A(20)	<1	20	700	<2
18	373	6				0.8	---						
19	375	6				0.5	---						
20	376	2	A	A(200)	A	1.0	.4	<10	A	A(1)	50	1,000	50
21	392	1				0.9	---						
22	409	3				0.8	---						
23	107	2	A	A	A	<.02	---	20	300	A	50	300	50
24	108	2	A	A	A	<.02	---	20	200	A	70	300	200
25	109	2	A	A	A	<.02	---	70	700	<1	70	300	30
26	110	2	A	A	A	0.1	---	50	700	<1	70	300	150
27	111	2	A	A	A	.03	---	70	1,000	<1	100	150	100
28	112	2	A	A	A	<.02	---	100	1,500	<1	70	150	50
29	113	2	A	A	A	<.02	---	20	200	A	70	300	20

Sample	Description
Samples 1-11 from Lillian prospect.	
1 -------	10-ft chip sample (2-in. interval) along reddish-brown quartz-arsenopyrite zone. Sample is in or near top of brown pyrite-bearing siltstone and below a hanging wall of gray argillite.
2 -------	Selected samples from No. 1 chip sample zone.
3 -------	Selected sample from No. 4 chip sample zone.
4 -------	7-ft chip sample (2-in. interval) in narrow (2-in.) reddish-brown to yellow-brown quartz-sulfide(?) vein in gray silty mudstone.
5 -------	Selected fragments from No. 4 chip sample zone.
6 -------	Selected quartz-arsenopyrite vein material from No. 4 chip sample zone.
7 -------	Do.
8 -------	Grab sample from altered, yellow-brown dike rock.
9 -------	Selected sulfide mass from interior of No. 8 dike.
10 -------	5-ft chip sample (2-in. interval) across altered dike.
11 -------	Selected material from friable, reddish-brown altered material containing quartz veinlets.
Samples 12-15 from Old Smoky prospect.	
12 -------	5-ft chip sample from biotite monzonite-quartzite contact zone; 3 narrow (1-in.) quartz-arsenopyrite veins are present in quartzite.
13 -------	Vein grab sample from No. 12 zone.
14 -------	Do.
15 -------	Do.
Samples 16-17 from Griffin prospect.	
16 -------	Adit tailings, grab samples of massive gray carbonate which contains quartz veins and is stained green by weathering of disseminated sulfides.
17 -------	Do.
Samples 18-19 from Sunshine No. 2 prospect.	
18 -------	Grab sample from altered yellow-brown dike.
19 -------	Selected sample from yellow-brown friable material in lower adit tailings.

analyses from lode prospects in the Livengood district

than;>, greater than; G, greater than 10; A, not detected; ---, not looked for; I, inter- and E. E. Martinez; results are reported to the nearest number in the series 1, 0.7, 0.5, Miller, and T. A. Roemer. Gold analyzed by fire assay by W. D. Goss, L. C. Huff, and T. L. in percent. Field numbers are shown in figure 2]

La	Mo	Mn	Nb	Ni	Pb	Sb	Sr	V	W	Y	Zn	Zr	Mg	Fe	Ca	Ti
50	15	300	10	15	50	100	1,000	200	50	20	<200	150	0.2	5	0.1	0.2
100	15	150	20	10	30	<100	1,000	100	70	50	<200	300	.05	7	.1	.2
A(20)	A(5)	100	<10	7	15	100	300	70	A	5	<200	50	.1	7	.05	.1
A	5	100	<10	10	<10	<100	1,500	50	A	A(5)	<200	30	.07	7	.07	.05
A	10	70	<10	7	20	200	700	70	A	10	<200	50	.1	10	<.05	.1
A	A	70	<10	7	<10	100	100	70	A	A	<200	20	.07	10	<.05	.1
<20	A	70	<10	15	A(10)	300	A(50)	30	A	<5	<200	<10	.05	10	<.05	.05
70	A	200	15	20	<10	A(100)	1,000	50	70	50	<200	200	.1	7	.3	.2
A	A	500	10	15	30	500	700	<10	150	A	200	A(10)	.02	20	.2	.007
100	10	500	30	100	20	1,500	700	70	50	50	300	500	.2	7	.2	.2
100	5	1,000	15	100	100	1,500	1,000	100	<50	50	300	200	1	7	1.5	2
A	A	100	<10	10	10	100	150	50	<50	A	<200	70	.1	10	.07	.07
A	A	100	<10	50	A	300	A	15	A	A	200	A	<.02	20	<.05	.007
A	A	150	<10	7	A	300	A	20	A	A	<200	20	<.02	20	<.05	.03
50	A	100	10	7	<10	100	150	70	<50	15	<200	100	.07	10	.15	.1
A	<5	1,000	A	1,000	15	500	700	30	A	A	<200	A	7	5	10	.05
A	A	1,000	A	300	<10	200	200	10	A	A	200	A	3	3	2	.003
A	<5	2,000	<10	300	<10	200	A	50	A	A	<200	<10	7	7	1	.05
A	A	1,500	<20	50	10	A	150	200	A	15	A	70	5	15	7	.7
A	A	1,500	<20	50	10	A	100	300	A	10	A	100	5	15	5	>1
A	A	2,000	<20	70	A	A	100	300	A	I	200	150	3	20	3	1
A	A	2,000	<20	100	A	A	200	500	A	I	200	150	2	20	5	>1
A	A	1,500	<20	70	A	A	A	300	A	I	200	150	1.5	>20	.7	.3
A	A	2,000	<20	70	A	A	200	200	A	30	<200	70	3	15	15	>1
A	A	2,000	<20	150	A	A	150	500	A	I	200	150	1.5	20	5	.5

Sample	Description
20 - - - - - - -	Grab sample from serpentinite scree. Sample 20 from Ruth Creek bench placer cut.
21 - - - - - - -	Grab sample from massive green-stained quartz-carbonate. Sample 21 from Gertrude Creek prospect.
22 - - - - - - -	Grab sample from yellow-brown silicic dike rock. Sample 22 from Lillian Creek prospect area.

Samples 23–29 from Ruth Creek prospect.

Sample	Description
23 - - - - - - -	Grab sample from gray (reddish-brown on weathered surface) medium-grained brecciated sulfide-bearing igneous rock composed of plagioclase, chlorite, and carbonate.
24 - - - - - - -	Grab sample from dark-gray (reddish-brown on weathered surface) fine-grained sulfide-bearing igneous rock composed of plagioclase, chlorite, and carbonate and containing quartz veinlets.

Sample	Description

Samples from Ruth Creek prospect—Continued

Sample	Description
25 - - - - - - -	Grab sample from light-gray (reddish-brown on weathered surface) fine-grained brecciated, sulfide-bearing sheared igneous rock made up of plagioclase, chlorite, and carbonate.
26 - - - - - - -	Selected sample from light-gray (reddish-brown on weathered surface) fine-grained sulfide-bearing cataclasite.
27 - - - - - - -	Selected sample from greenish-gray fine-grained sulfide-bearing cataclasite.
28 - - - - - - -	2.5-ft chip sample (4- to 5-in. interval) in light-gray (reddish-brown on weathered surface) massive sulfide-bearing carbonate metasomatite derived from the replacement of igneous breccia.
29 - - - - - - -	Selected sample from light-gray (reddish on weathered surface) brecciated cataclasite.

Table 3.--Semiquantitative spectrographic analyses and gold

[Looked for but not detected: Au (spectrographic), Bi, Cd, Hg, Pt, Pd, Rh, Ta, Te. Symbols (.5), lower limit of detectability. Spectrographic analyses by Arnold Farley, Jr.; results on. Gold analyzed by atomic absorption by A. L. Meier, R. L. Miller, and T. A. Roemer. cent. Field numbers are shown in figure 2]

Sample No.	Lab. No.	Field No.	Ag	As	Au Atomic absorp- tion	B	Ba	Be	Co	Cr	Cu	La	Mo	Mn
1	ACE-001	3	A(.5)	300	<0.02	50	700	7	A(10)	A(10)	30	150	5	150
2	002	3	A	A(200)	<.02	100	700	10	A	A	50	200	15	150
3	003	3	A	1,500	.04	100	2,000	20	A	A	50	300	10	150
4	004	3	A	200	<.02	100	1,500	15	A	A	70	200	5	150
5	005	3	A	500	.02	100	2,000	15	A	A	30	200	7	100
6	006	3	A	500	<.02	100	2,000	10	A	A	30	200	15	150
7	007	3	A	A	<.02	30	500	3	70	700	50	50	10	1,500
8	014	3	A	A	<.02	70	700	2	A	A	30	100	A(5)	2,000
9	087	2	2	1,000	---	300	>5,000	5	10	30	30	200	15	100
10	091	4	A	A	---	70	300	10	A	10	50	70	A	1,500
11	117	1	A	500	<.02	70	2,000	2	10	50	30	200	5	700
12	183	5	A	A	.04	70	1,000	5	A	10	20	100	A	1,000
13	192	4	A	A	.02	30	700	10	100	30	30	200	A	1,000

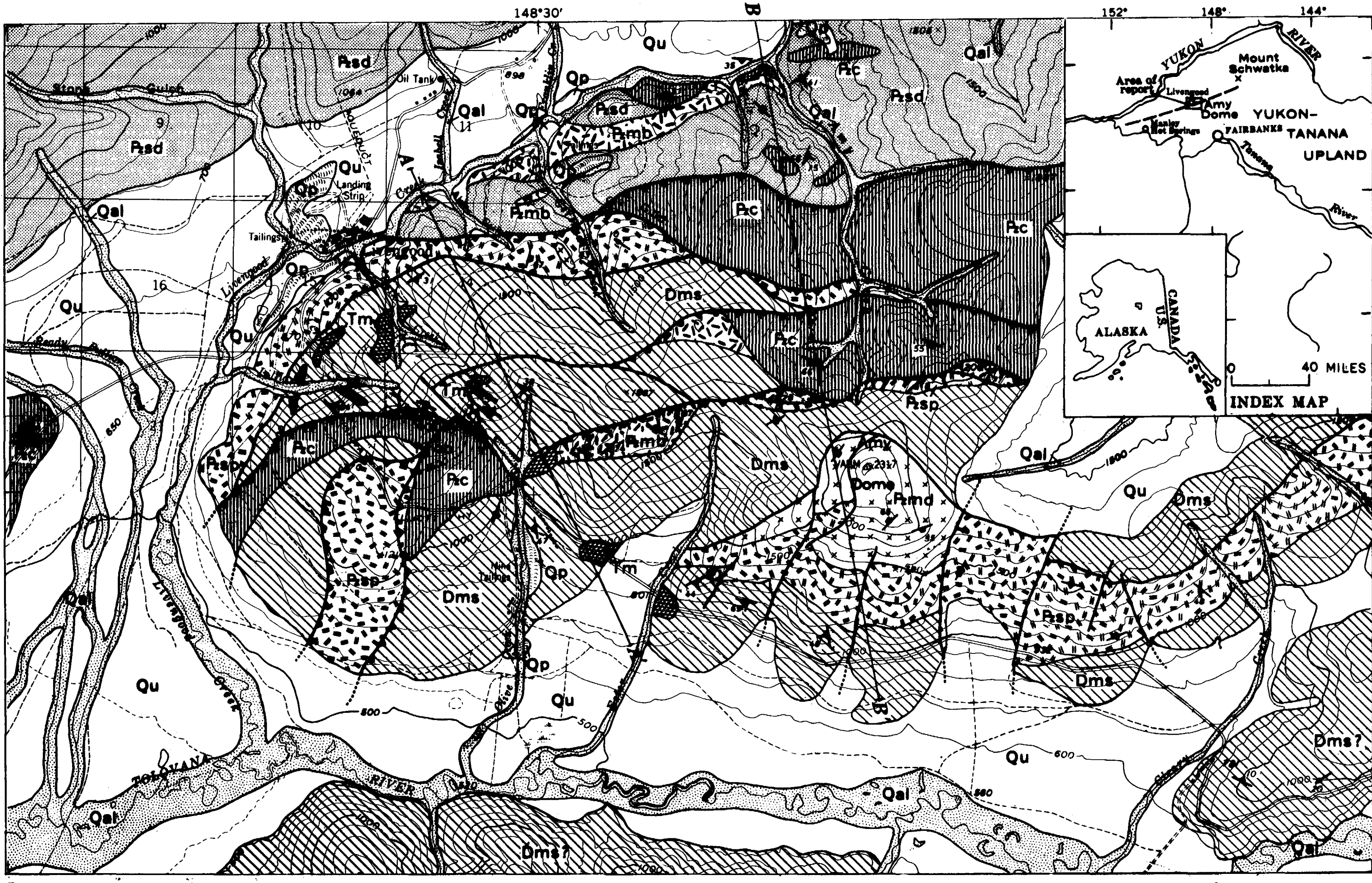
Sample	Description
1-6	10-ft chip samples (2-in. interval in bedrock; continuous sampling on soft material). Bedrock sample is sulfide-bearing gray to dark-gray (dark brown on weathered surface) altered porphyritic fine-grained latite(?) with sericite and limonite masses adjacent to fractures; quartz nests and veinlets common; opaque minerals associated with fractures, quartz nests, and matrix material. Soft material is essentially limonitic igneous rock decomposed in place.
7	Grab sample from altered sulfide-bearing gray (reddish-brown on weathered surface) igneous rock with minor chlorite and sericite; approximately 70 percent of rock is replacement carbonate.
8	Grab sample from altered sulfide-bearing dark-gray (brown on weathered surface) porphyritic fine-grained latite(?) with quartz veinlets, quartz nests, minor sericite and carbonate, and disseminated opaque minerals.

analyses by atomic absorption of rocks from the Livengood district

used: <, less than; >, greater than; A, not detected; ---, not looked for; I, interference; are reported to the nearest number in the series 1, 0.7, 0.5, 0.3, 0.2, 0.15, 0.1, and so results are given in parts per million except for Mg, Fe, Ca, Ti, which are given in per-

Nb	Ni	Pb	Sc	Sb	Sn	Sr	V	W	Y	Zn	Zr	Mg	Fe	Ca	Ti
70	A(2)	50	A	A(100)	20	A(100)	15	A(50)	70	<200	>1,000	0.7	5	<0.05	0.2
200	A	70	10	A	30	A	20	A	150	<200	>1,000	.5	7	<.05	.5
300	A	70	10	A	50	A	20	A	150	300	>1,000	.7	10	<.05	.5
300	A	100	10	A	30	A	20	A	150	200	>1,000	.7	10	<.05	.5
200	A	70	15	A	50	A	20	A	150	200	>1,000	.7	15	<.05	.5
200	200	70	10	A	50	A	15	A	150	300	>1,000	.7	10	<.05	.5
<20	3	A	30	I	A	500	200	A	15	<200	150	1.5	15	5	1
50	A	50	A	A	A	150	20	A	70	200	300	.7	10	.3	.5
30	150	200	20	500	A	2,000	200	70	30	300	300	.2	7	.2	.3
200	20	30	15	A	I	A	10	A	200	500	>1,000	.2	7	.07	.2
50	2,000	30	A	A	A	A	20	A	70	A	700	.5	7	.2	>1
30	A	30	100	A	A	A	20	A	50	A	200	.7	10	.3	.5
200	10	200	10	A	30	A	<10	A	150	500	>1,000	.3	15	.05	.2

Sample	Description
9	Grab sample from sulfide-bearing yellowish-brown medium-grained monzonitic(?) dike rock with secondary limonite, quartz, sericite, and clinozoisite.
10	Scree grab sample from dark-gray to dark-grayish-brown (brown on weathered surface) porphyritic medium-grained quartz monzonite; pseudographic texture with quartz enclosing brown-stained K-feldspar and plagioclase.
11	Grab sample sulfide-bearing gray (reddish-brown on weathered surface) porphyritic fine-grained latite(?) with quartz nests and minor carbonate.
12	Grab sample from sulfide-bearing dark gray (brown on weathered surface) medium-grained monzonite; limonite stain common.
13	Scree grab sample from brownish-gray (brown on weathered surface) porphyritic medium-grained quartz monzonite with limonite stain. Minor elements (table 3) indicate this rock to be a possible late-stage differentiate.



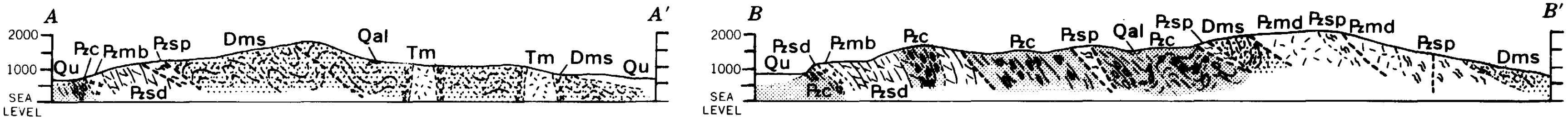
Base from U.S. Geological Survey
Livengood (C-4), 1952; Livengood (B-4), 1953;
Livengood (C-3), 1954; and Livengood (B-3), 1954

SCALE 1:63 360

1 ½ 0 1 2 MILES

CONTOUR INTERVAL 100 FEET

Geology by R. L. Foster, 1967



EXPLANATION

Holocene — QUATERNARY

Qp — Placer workings

Qal — Flood-plain alluvium

Qu — Surficial deposits, undifferentiated

TERTIARY (?)

Tm — Monzonitic rocks

Upper Middle Devonian — DEVONIAN

Dms — Black and dark-gray to grayish-brown graywacke and argillite

Includes alternating arenaceous and argillaceous clastic beds of Devonian (?) age south of the Tolovana River and east of Cleary Creek

FAULT AND UNCONFORMITY

PALEOZOIC

Pzmd — Green fine- to coarse-grained metadiorite (dike equivalents included in Pzsp)

Pzsp — Dark- to light-green serpentinite, peridotite, metabasalt, tectonic inclusions, and silica-carbonate-talc metasomatites

PALEOZOIC

Pzmb — Dark-green metabasalt (locally sheared)

Pzsd — Gray siliceous dolomite with interbedded gray and black chert

Pzc — Black and gray banded chert breccia, black marble, volcani-clastic and tuffaceous beds

?

Contact

Approximately located; queried where doubtful

Fault

Dotted where concealed; bar and ball on downthrown side

Thrust or reverse fault

Dotted where concealed; sawteeth on upper plate or hanging wall side

10 38

Vertical Inclined $S_1 = S_2$

Strike and dip of foliation

55

Vertical Inclined

Strike and dip of joints

20

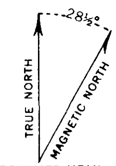
Strike and plunge of lineation

Vein

Adit

F

Fossil location



APPROXIMATE MEAN DECLINATION, 1968

Figure 1.--Generalized geologic map and sections of the Livengood district.

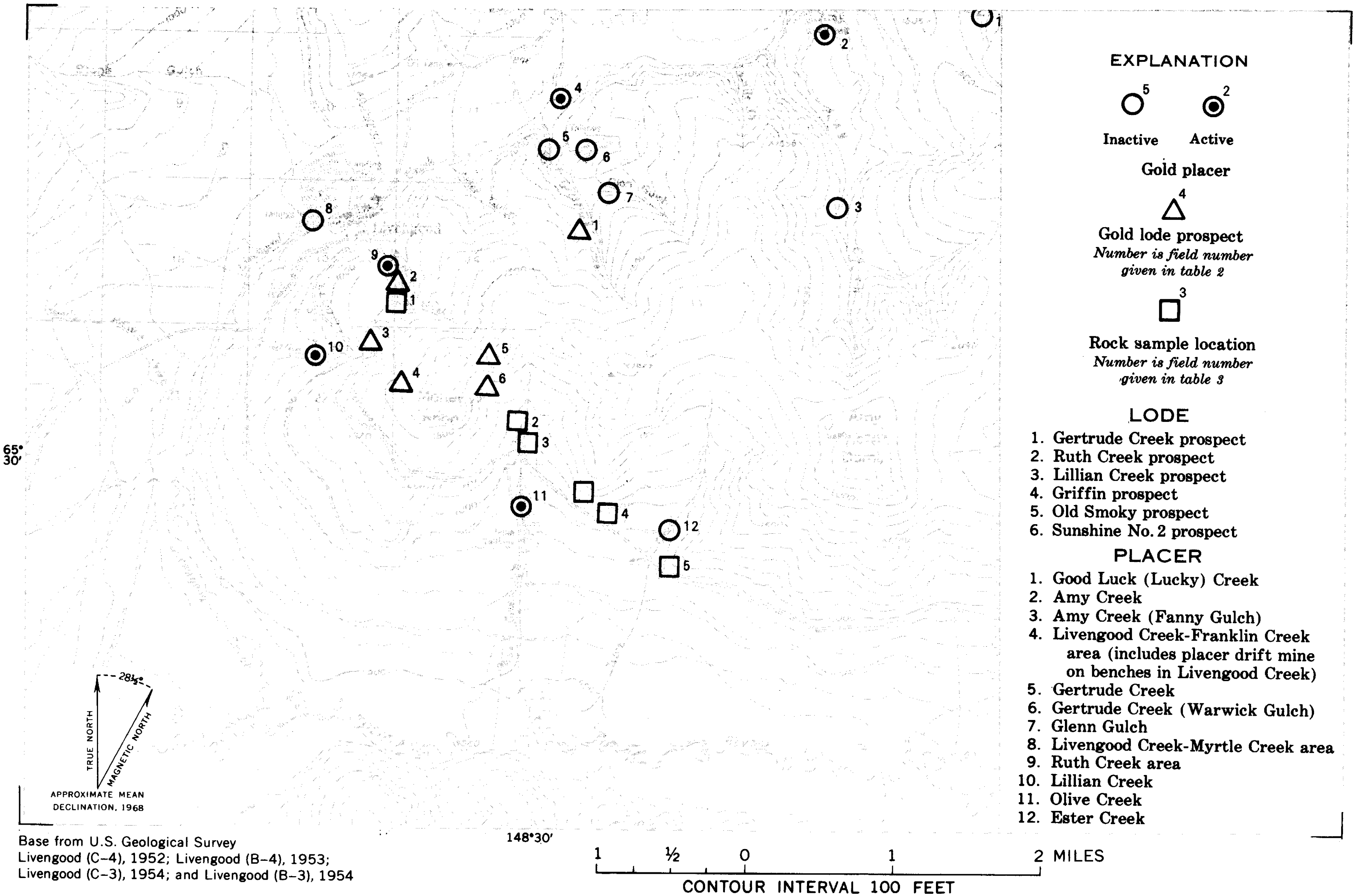
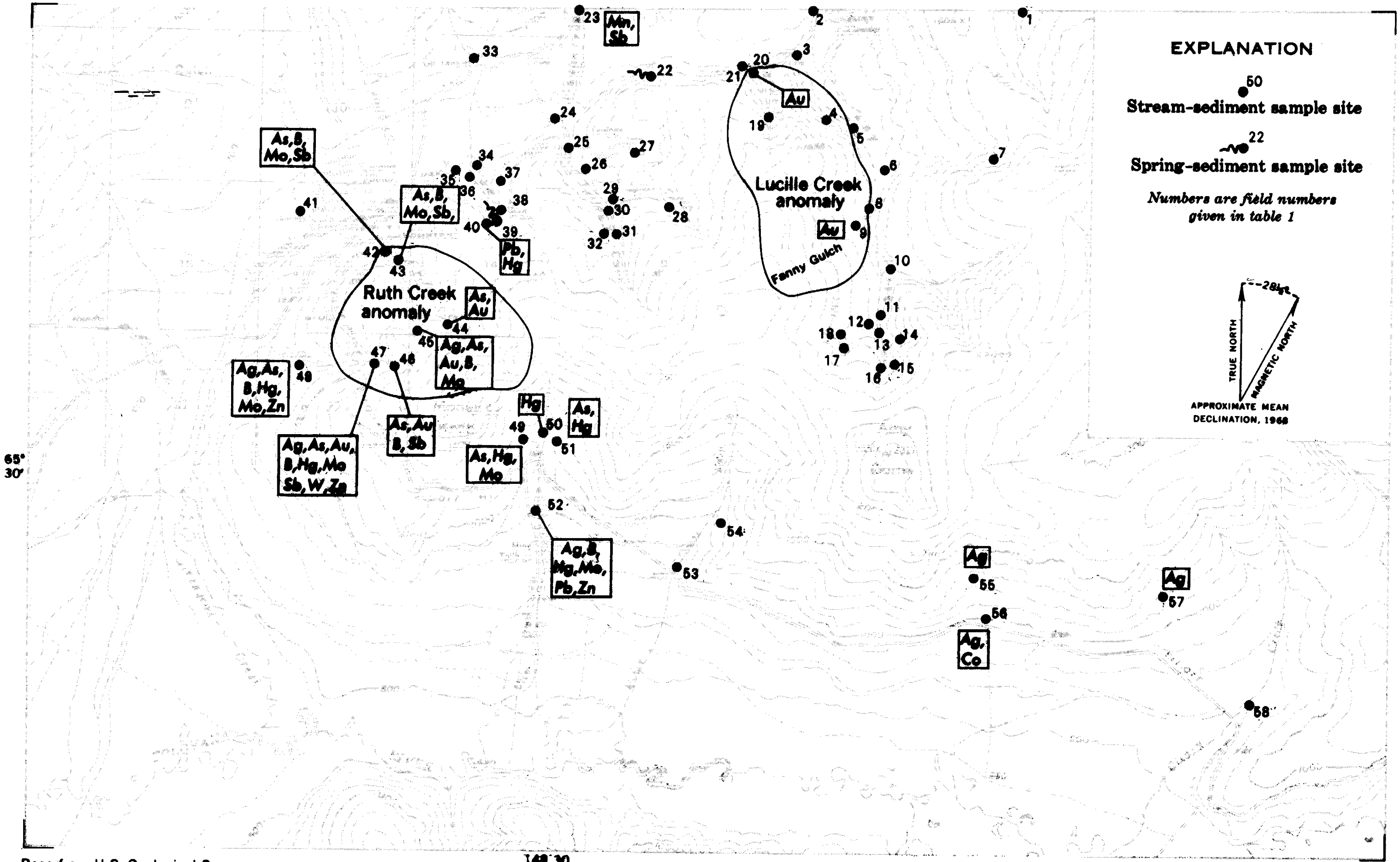


Figure 2.--Map showing distribution of gold lode prospects and productive gold placer deposits in the Livengood district.



Base from U.S. Geological Survey
Livengood (C-4), 1952; Livengood (B-4), 1953;
Livengood (C-3), 1954; and Livengood (B-3), 1954

1 ½ 0 1 2 MILES

CONTOUR INTERVAL 100 FEET

Figure 3.--Map of Livengood district showing location of stream- and spring-sediment samples and anomalous metal concentrations.

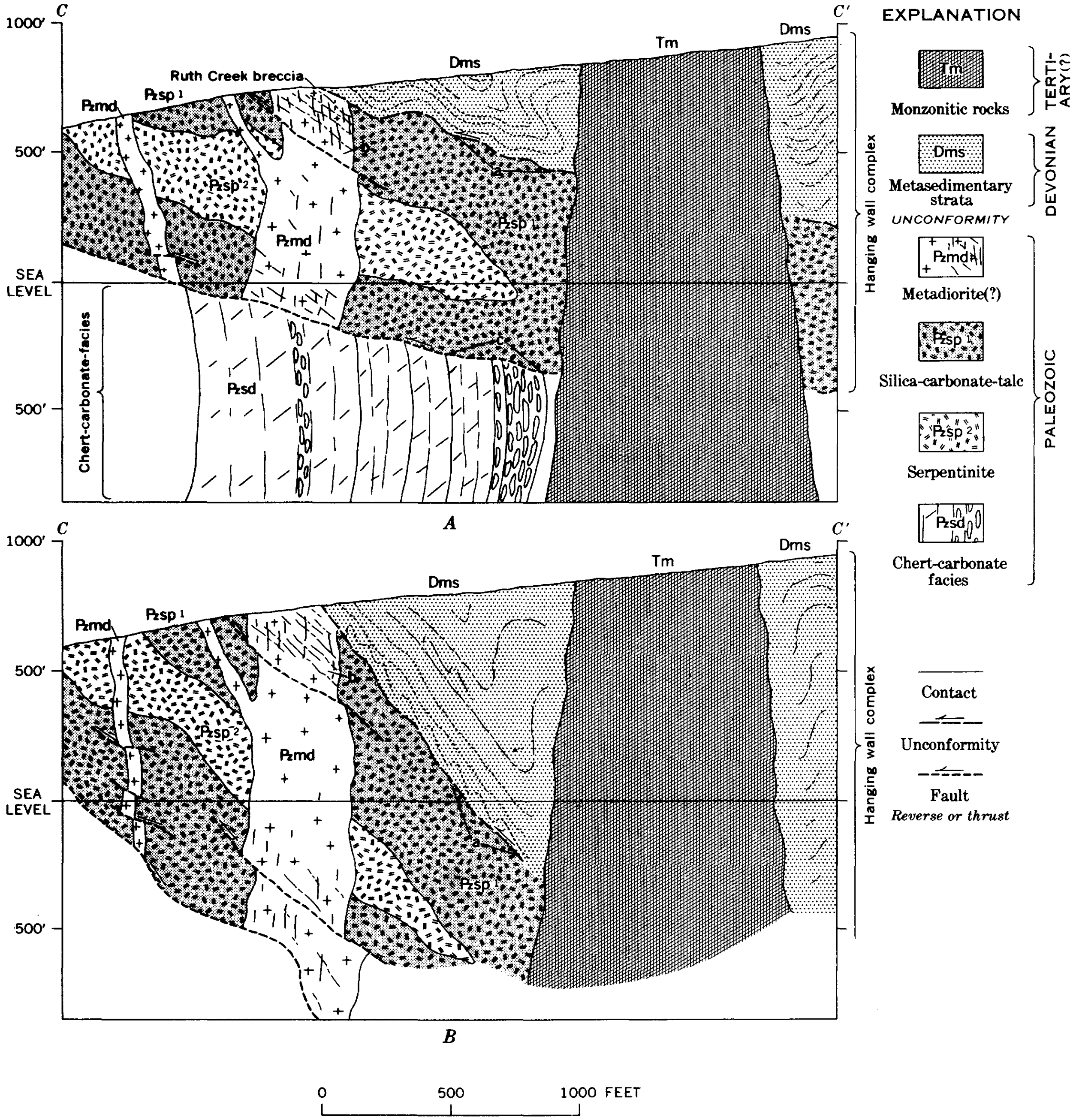


Figure 4.--Digrammatic geologic cross sections of the Ruth Creek area, (C—C' in fig. 1), showing alternative structural interpretations. A. Thrust interpretation, with possible mineralization in: a, silica-carbonate-talc selvage below faulted unconformity; b, brecciated mafic stock; and c, chert-carbonate footwall complex. B. High-angle reverse or strike-slip fault interpretation with mineralization in: a, silica-carbonate-talc selvage; and b, brecciated mafic stock.

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