GEOLOGICAL SURVEY CIRCULAR 593

Distribution of Gold and Some Base Metals in the Slana Area, Eastern Alaska Range, Alaska

Work done in cooperation with the State of Alaska, Division of Mines and Minerals

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Abstract

In the Slana area of the eastern Alaska Range, Paleozoic and Mesozoic sedimentary and volcanic rocks have been extensively intruded by two suites of igneous rocks, one dioritic and one quartz monzonitic. Anomalous concentrations of gold and copper are associated with diorite-quartz diorite intrusives, as indicated by stream-sediment and bedrock samples, and anomalous concentrations of lead-zinc and lead-molybdenum are associated with the zoned Ahtell Creek quartz monzonite-granodiorite pluton. Metal concentrations as high as 7 ppm (parts per million) gold, 365 ppm zinc, 250 ppm lead, and 25 ppm molybdenum have been found in the stream sediments. The distribution of gold in bedrock follows very closely the pattern shown by the stream-sediment data. Random samples of dioritic rocks and their hypabyssal equivalents, from areas drained by streams anomalously high in gold, contain as much as 0.3 ppm gold. The data suggest that (1) placer gold deposits may be present in streams draining the principal area anomalous in gold and (2) bedrock sources of the anomaly should be evaluated as possible low-grade disseminated gold deposits.

INTRODUCTION

The Alaska Division of Mines and Minerals made geologic and geochemical studies of the Slana area of the eastern Alaska Range from 1963 to 1966. These studies resulted in a geologic report (Richter, 1966) and in the identification of two base-metal anomalies (Richter, 1965). The investigations were continued and extended by the U.S. Geological Survey in 1967 as part of its Heavy Metals program particularly to determine the relationship of gold to the geologic setting. Gold analyses made on all the stream-sediment samples and many rock samples collected during the State-sponsored studies disclosed several gold anomalies and the fact that the geologic associations of gold are markedly different from those of the base metals. This report presents all the newly available data on gold distribution as related to geology of the Slana area together with a review of the published data on the base metals.

The Slana area, as informally referred to here, covers approximately 240 square miles on the south flank of the eastern Alaska Range, mostly between the Chistochina and Slana Rivers (fig. 1). It includes parts of the Gulkana C-1 and D-1 and the Nabesna C-6 and D-6 quadrangle maps (scale 1:63,360). The Tok Cutoff of the Glenn Highway runs about 26 miles through the area and affords relatively easy access to most of the back country.

GEOLOGIC SETTING

The Slana area lies south of the Denali fault, a major trans-Alaska strike-slip lineament, in a region of upper Paleozoic and Mesozoic sedimentary and volcanic rocks that have been intruded by two compositionally and texturally distinct groups of igneous rocks. A generalized stratigraphic column and brief description of the bedded rocks are given below.

Age	Description
Cretaceous and Jurassic	Argillite containing interbedded siltstone, graywacke, and conglomerate.
Angular unconformity.	
Permian	Amygdaloidal basalt containing interbedded limestone, basalt, and limestone conglomerate.
Unconformity.	
Permian	Limestone, argillite, and minor coarser grained clastic rocks (Mankomen? Formation).
Permian	Volcaniclastic rocks containing minor impure limestone.
Permian and Pennsylvanian(?)	Andesitic volcanic rocks, including flows, tuffs and breccias, mud-avalanche deposits, and volcaniclastic rocks.

This sedimentary and volcanic sequence, except for some of the younger Mesozoic rocks, was intruded by a large heterogeneous diorite-quartz diorite complex and a number of satellitic(?) bodies whose composition was similar but also included granodiorite, gabbro, and anorthosite. A more alkalic, zoned pluton of quartz monzonite and granodiorite, termed the Ahtell Creek pluton in previous reports, intruded the Permian volcanic and volcaniclastic rocks in the western part of the area. Both groups of intrusive igneous rocks are younger than Permian and probably older that Late Jurassic, although neither their absolute nor relative age is well known.

The structural grain of the area, revealed by faults, fold axes, bedding, and orientation of some of the dioritic intrusives, parallels the northwestward trend of the Alaska Range and its tectonic elements. Only the Ahtell Creek pluton, which trends northward, appears to be discordant with the regional structure. Bedding and flow layering in most of the rocks dip at moderate angles to the northeast toward the Denali fault.

ECONOMIC GEOLOGY

Prospecting has been carried out in the Slana area since before the turn of the century, and between then and the early 1930's a number of argentiferous base-metal quartz veins were discovered. Placer gold was also discovered during the early prospecting. Figures 4-8 show the distribution of gold and base metals in the area. The letters and numbers used with references to figures in subsequent sections are map coordinates.

It was not until 1934 that a placer deposit on Grubstake Creek (fig. 4, D–3) was exploited commercially (Moffit, 1938, p. 48–50). This placer deposit and another on Slope Creek (fig. 4, D–4), which drains the same general area, have been worked intermittently since then. Total gold production from these two deposits probably has been less than $30,000, and at present (1968) both properties are inactive. There is no recorded production from any of the veins in the area; however, two prospects, the Silver Creek (figs. 4–8, F–3) and the Silver Shield (figs. 4–8, E–4), are currently being explored.

The veins and the lead, zinc, and molybdenum anomalies are spatially and apparently genetically related to the Ahtell Creek quartz monzonite-granodiorite pluton. These veins and anomalies indicative of possible mineral deposits occur chiefly in the fine-grained border zone around the southern lobe of the pluton and in adjacent hornfels country rock. Most of the veins are thin simple hydrothermal fissure fillings which are dominantly massive white quartz and locally minor barite and carbonate minerals and scattered crystals or segregations of galena, chalcopyrite, sphalerite, and argentiferous tetrahedrite. In the strongly altered area south of Long Lake (figs. 4–8, C–2), small scattered flakes of molybdenite are associated with quartz, pyrite, and sericite.

The placer gold in Grubstake and Slope Creeks is fine grained and wiry and shows no evidence of lengthy transport. Earlier it had been thought that the gold was also derived from lode deposits within the border zone of the Ahtell Creek pluton (Richter, 1965); however, the data presented here suggest that the gold is not associated with this pluton but rather with the more mafic diorite-quartz diorite intrusives.

GEOCHEMISTRY

The geochemical data presented in this report are based on the chemical and spectrographic analyses of 258 samples of stream sediments and 105 samples of rock collected between 1963 and 1967. These data show anomalous concentrations of gold and base metals in many stream sediments throughout the Slana area and define a number of anomalies which may be significant. Emphasis is directed toward the gold anomalies and the distribution of gold in the country rock; the base-metal anomalies have been discussed in earlier reports (Richter, 1965, 1966), and only a brief review of their salient features is presented here.

Sample locations for both stream sediments and rocks are shown in figure 2. Analytical results are given in tables 1 and 2 and are shown on the metal-distribution maps (figs. 4–8).

Sampling and Analytical Procedures

Stream-sediment samples were collected from active streams at sites yielding as much fine material as possible. Copper, lead, zinc, and molybdenum analyses were made on the -80-mesh fraction of all samples by a number of laboratories using colorimetric, atomic-absorption, or spectrographic techniques (see headnote, table 1). Gold analyses were also made on the -80-mesh material by Geological Survey laboratories using a hydrobromic acid extraction and atomic-absorption spectrophotometry. For samples weighing 10 grams or more the lower limit of determination for gold was 0.02 ppm (parts per million). However, many samples weighed less than 10 grams, and for these, 5-, 2-, or even 1-gram amounts were used; these small samples raised the lower limit of determination to 0.04, 0.1, and 0.2 ppm gold, respectively. Hence, not all gold values are directly comparable, and it is very probable that many of the small samples contain gold in concentrations exceeding 0.02 ppm.

The 105 rock samples analyzed for gold were selected from available specimens in an attempt to insure a representative suite of the various rock types and to give as much geographic coverage as possible. The samples were crushed, ground to -150 mesh, and analyzed by the same method used for the stream sediments. Ten grams of material was available for all the rock analyses.

Background and Anomalous Concentrations of Metals

Data on the concentration of gold, copper, lead, zinc, and molybdenum in the rocks and stream sediments of the Slana area are summarized in table 3 and compared with average crustal abundances of these elements.

These data indicate that the Slana area as a whole is not anomalous with respect to any of the analyzed elements. All the elements—with the possible exception of gold, for which data below a concentration of 0.02 ppm are not available—generally occur in concentrations of the same order of magnitude as their estimated abundance in the earth's continental crust. Moreover, both the mode (most frequent concentration) calculated from stream-sediment samples and the mean and mode calculated from rock samples for the four base metals are virtually the same. The apparent low mode for copper in rocks may be due to limited rock-sample data.

In this report, concentrations of copper, lead, zinc, and molybdenum approximately three times mean background or more are considered anomalous; these concentrations are for copper, 150 ppm; lead, 30 ppm; zinc, 180 ppm; and molybdenum, 6 ppm. These values correspond roughly to the break point on the log-normal frequency distribution curves of the metals in stream sediments of the Slana area (Richter, 1966). For gold the lower limit of detection, or 0.02 ppm, is considered anomalous.

Distribution of Metals in Stream Sediments

The two conspicuous base-metal anomalies in the area, mentioned and described previously (Richter, 1965, 1966), are obvious from inspection of the metal distribution maps. The largest of these is a lead-molybdenum anomaly in the vicinity of Long Lake (figs. 6 and 8, C–1, –2, and D–1, –2). Slightly anomalous zinc concentrations were detected in a few streams, but with the exception of one stream, copper was not present in amounts much above background. The other anomaly, high in lead and zinc, is south of Flat Creek (figs. 6 and 7, E–2 and F–2). Both anomalies are largely within the border zone of the Ahtell Creek pluton. Conspicuous quartz-pyrite alteration zones, some as large as 5 acres in extent, and a few thin quartz-sulfide veins are exposed near Long Lake. The Flat Creek anomaly, which is currently being explored by private industry, is in an area of low relief and extensive tundra cover, and no mineralized outcrops were found.

West of Ahtell Creek a number of streams draining the border zone of the Ahtell Creek pluton contain slightly anomalous amounts of one or more base metals. The relatively high concentration of lead in E–4 (fig. 6) is on a small stream draining the Silver Shield silver-lead prospect.

Copper is rather widely distributed throughout the area and shows a closer spatial association with the diorite-quartz diorite intrusives than with the Ahtell Creek pluton. Anomalous concentrations of copper occur sporadically along the entire southwest flank of the large diorite-quartz diorite mass and locally around a number of the smaller dioritic intrusives (fig. 5). The strongest anomaly, which shows concentrations as high as 400 ppm, is southwest of Indian Pass Lake (fig. 5, C–4, –5 and D–4) in an area of numerous small hornblende-diorite intrusives. Another small hornblende-diorite intrusive in B–2 and C–3 is also the apparent source of a smaller anomaly. The hornblende diorites in both these anomalous areas are locally pyritized and conspicuously limonite stained. The single copper anomaly in the northeast part of the area (fig. 5, A–9) is on a stream draining cupriferous amygdaloidal basalts and is the only anomaly not known to be related to intrusive rocks.

The distribution of gold in the Slana area, as defined by the analyses of stream sediments, shows, like copper, a marked association with the diorite intrusives and with a few exceptions does not correspond to the distribution of the other base metals. Of more than 30 streams with detectable gold, only five drain the quartz-vein-rich border zone of the Ahtell Creek pluton and its peripheral hornfels zone. Three of these, including one with the strongest stream-sediment anomaly detected (7.1 ppm gold), are in an area where dioritic rocks also occur (fig. 4, F–2).

The strongest and most conspicuous gold anomaly is southwest of Indian Pass Lake (fig. 4, C–4, –5 and D–4) in an irregular area underlain by a number of small hornblende diorite intrusives and is coincident with the strong copper anomaly. Sediments in 13 streams draining the area contain more than 0.02 ppm gold, and sediments in three of these contain 2 ppm gold. The local placer gold in Grubstake and Slope Creeks apparently also has its source in this area and not in the nearby border zone of the Ahtell Creek pluton, as previously thought. Surprisingly, the sediments in Grubstake Creek, the larger of the two placer deposits, are only moderately enriched in gold (0.04 ppm, sample 94), and this fact suggests that some other streams, which show much higher gold concentrations, could also contain gold placer deposits.

Elsewhere in the area anomalous concentrations of gold occur principally along the southwest border of the large diorite-quartz diorite complex (fig. 4, B–5 and C–6), southeast of the Slana River around an arcuate quartz diorite intrusive (fig. 4, D–8, –9 and E–8), and west of Ahtell Creek near a small diorite intrusive (fig. 4, B–3). These three anomalies are defined by only a few stream-sediment samples with gold concentrations generally well below 2 ppm and are not nearly as promising as the anomaly near Indian Pass Lake.

Distribution of Gold in Rocks

Gold analyses on 105 rocks collected throughout the area as representative geologic samples—not as ore mineral samples—show a gold distribution pattern similar to that shown by the stream-sediment data. Gold analyses of rocks are listed in table 2 and plotted on the gold distribution map (fig. 4).

Only 11 of the rocks analyzed contain detectable gold (0.02 ppm or more), and all these are diorites, quartz diorites, or hornblende-feldspar porphyries believed to be hypabyssal equivalents of the dioritic rocks. Moreover, none of the rocks containing detectable gold is from an area outside the anomalies defined by the stream sediments. In particular, the anomaly southwest of Indian Pass Lake includes the most rock samples (seven) showing enrichment in gold and also the sample with the highest gold content (0.3 ppm, sample R60). Two diorite samples from the anomalous area in B-5 (fig. 4) are enriched in gold, as are two quartz diorite samples from the anomalous area southeast of the Slana River. Many of the rocks containing detectable gold also contain disseminated pyrite, but pyrite is common in intrusive rocks in the area and probably is equally or more abundant in some of the analyzed quartz monzonite-granodiorite rocks and hornfels.

ECONOMIC POTENTIAL

The gold geochemical anomaly in the central part of the Slana area appears to warrant further exploration. Sediments in at least three streams draining the anomalous area contain in excess of 2 ppm gold, a fact suggesting the presence of local placer deposits. However, it is probable that the original lode gold (possibly in quartz veins) was coarse enough to supply material for workable placer deposits only in the restricted area in the border zone of the Ahtell Creek pluton at the head of Grubstake and Slope Creeks. If, as seems likely, the gold is disseminated throughout the diorites, gold particles in the other streams draining the anomalous area may be extremely fine grained and not recoverable by conventional placer mining.

The possibility of a large low-grade lode deposit within the apparent dioritic source rocks of the anomaly should not be discounted. Detailed sampling of the dioritic intrusives, especially the more pyrite-rich areas, may reveal gold concentrations higher than the 0.3 ppm found in this reconnaissance sampling of the bedrock.

Diorite and quartz diorite intrusives are not restricted to the Slana area of the eastern Alaska Range but are known to occur throughout the range from western Alaska through Canada to southeast Alaska. In many areas these dioritic rocks are conspicuously altered and (or) contain abundant disseminated sulfides. However, little is known concerning the gold content of these rocks. One area in which gold deposits seem to be genetically related to diorite is in the Chulitna district of the central Alaska Range, where Ross (1933) reported that some of the lodes are disseminated iron sulfide deposits in diorite porphyry.

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Taylor, S. R., 1964, Abundance of chemical elements in the continental crust—A new table: Geochim. et Cosmochim. Acta, v. 28, no. 8, p. 1273-1285.

Table 1.--Gold and base-metal content of stream sediments

[N, not detected (below value shown in parentheses). Ins., insufficient sample for analysis. Analysts: Gold, all samples (atomic absorption), W. L. Campbell, R. L. Miller, M. S. Rickard, and T. A. Roemer; base metals, samples (map No.) 210, 211, 232-234, 239, 244-247 (semiquantitative spectrographic), K. J. Curry and R. T. Hopkins; base metals, all other samples (colorimetric and atomic absorption), various (see Richter, 1965, 1966)]

Map No. (fig. 2)	Sample No.		Sample weight (g)	Concentration (ppm)				
	Laboratory	Field		Au	Cu	Pb	Zn	Mo
1	355	5D-91	10	N(0.02)	135	15	95	2
2	356	92	5	N(.04)	50	15	90	2
3	357	93	10	N(.02)	55	15	65	1
4	358	94	10	N(.02)	45	10	60	1
5	359	95	10	N(.02)	50	15	60	1
6	354	88	5	N(.04)	60	20	90	1
7	361	98	10	N(.02)	40	10	70	1
8	362	99	10	N(.02)	20	10	65	1
9	565	DR-64-451	10	N(.02)	40	10	40	---
10	564	450	5	N(.04)	55	15	60	---
11	648	454	.1	2.0	250	15	80	---
12	649	455	1	N(.2)	175	20	80	---
13	650	456	2	N(.1)	450	30	100	---
14	637	395	1	N(.2)	250	5	105	2
15	563	448	2	N(.1)	75	20	80	1
16	562	442	5	N(.04)	50	30	65	---
17	555	430	2	N(.1)	110	70	115	---
18	646	440	2	N(.1)	100	75	120	1
19	561	441	2	N(.1)	175	90	150	4
20	560	439	10	.02	75	100	85	3
21	559	438	10	N(.02)	50	30	60	---
22	558	437	5	N(.04)	45	20	55	---
23	644	433	1	N(.2)	150	180	60	4
24	360	5D-96	10	N(.02)	25	10	65	2
25	581	DR-64-477D	5	N(.04)	185	100	140	10
26	582	478	5	N(.04)	125	50	75	---
27	580	476	2	N(.1)	140	35	55	2
28	579	475	10	N(.02)	75	30	60	---
29	578	474	5	N(.04)	140	40	60	1
30	643	427	10	N(.02)	135	200	140	---
31	554	428	2	N(.1)	85	150	95	4
32	568	459	10	N(.02)	55	55	190	---
33	569	461	10	N(.02)	70	200	115	---
34	577	472	5	N(.04)	70	65	120	---
35	570	462	5	N(.04)	55	220	140	1
36	572	464	5	N(.04)	30	35	120	---
37	573	465	5	N(.04)	55	100	300	1
38	575	468	5	N(.04)	40	10	90	---
39	574	467	10	N(.02)	40	180	180	---
40	647	445	1	N(.2)	125	250	75	6
41	645	436	5	N(.04)	45	100	110	---
42	557	435	2	.3	85	35	300	25
43	556	434	2	N(.1)	100	80	185	4
44	566	457	10	N(.02)	55	65	115	---
45	567	458	5	N(.04)	40	10	60	---

Table 1.--Gold and base-metal content of stream sediments--Continued

Map No. (fig. 2)	Sample No.		Sample weight (g)	Concentration (ppm)				
	Laboratory	Field		Au	Cu	Pb	Zn	Mo
46	588	DR-64-497	2	N(0.1)	40	45	70	3
47	551	411	10	N(.02)	40	50	140	---
48	550	410	10	N(.02)	35	30	60	---
49	549	409	2	N(.1)	40	45	110	---
50	542	374	5	N(.04)	70	15	135	2
51	541	373	5	N(.04)	45	80	340	2
52	540	372	10	N(.02)	30	10	60	1
53	539	367	2	N(.1)	45	30	110	2
54	538	364	2	N(.1)	45	30	100	2
55	636	370	Ins.	---	75	20	110	2
56	535	361	10	N(.02)	75	45	235	2
57	584	482	2	N(.1)	75	30	105	2
58	585	484	2	N(.1)	75	65	160	4
59	518	318	2	N(.1)	100	55	300	6
60	651	488	1	7.1	45	45	205	2
61	652	489	2	N(.1)	70	50	365	3
62	536	362	5	N(.04)	45	40	160	2
63	534	360	2	N(.1)	70	50	210	2
64		495	Ins.	---	60	215	300	4
65	654	494	2	N(.1)	45	90	190	4
66	530	351	2	N(.1)	80	65	145	5
67	529	350	2	.7	90	55	140	4
68	635	352	1	N(.2)	160	140	205	4
69	537	363	1	N(.2)	40	100	110	3
70	528	348	2	N(.1)	50	45	125	3
71	532	355	10	N(.02)	40	20	60	4
72	533	357	2	N(.1)	185	25	175	3
73	531	354	2	N(.1)	55	25	210	2
74	653	492	1	N(.2)	55	55	150	4
75	513	308	10	.2	75	70	175	4
76	512	307	10	N(.02)	35	5	65	2
77	527	346	2	N(.1)	50	15	110	2
78	526	345	10	N(.02)	45	10	60	---
79	525	344	10	N(.02)	30	55	5	2
80	511	304	10	N(.02)	20	5	65	2
81	522	336	5	N(.04)	30	5	70	1
82	514	311	5	N(.04)	20	5	35	2
83	519	325	5	N(.04)	40	15	55	---
84	521	333	2	N(.1)	40	5	90	---
85	520	331	2	N(.1)	30	5	60	2
86	593	520	2	N(.1)	55	15	95	---
87	307	5D-1	10	N(.02)	45	80	205	3
88	548	DR-64-404	5	.6	35	40	95	---
89	638	402	10	N(.02)	35	35	60	---
90	547	401	Ins.	---	60	50	240	---
91	639	405	5	N(.04)	50	45	190	---
92	546	398	2	N(.1)	80	45	105	---
93	543	380	2	N(.1)	45	20	105	---
94	363	5D-100	10	.04	215	30	90	4
95	544	DR-64-390	2	N(.1)	35	5	55	---

Table 1.--Gold and base-metal content of stream sediments--Continued

Map No. (fig. 2)	Sample No.		Sample weight (g)	Concentration (ppm)				
	Laboratory	Field		Au	Cu	Pb	Zn	Mo
96	---	63-A-62	Ins.	---	70	25	80	---
97	545	DR-64-392	2	N(0.1)	45	30	60	5
98	552	413	5	N(.04)	45	15	145	---
99	640	417	5	.08	40	25	150	---
100	641	419	5	N(.04)	40	40	200	3
101	642	420	1	N(.2)	100	5	110	---
102	553	421	2	.1	80	10	100	---
103	353	5D-65	5	N(.04)	100	5	85	7
104	349	60	5	N(.04)	95	10	85	5
105	348	59	5	N(.04)	150	15	80	7
106	347	58	10	.02	200	10	85	7
107	346	57	5	N(.04)	160	5	65	5
108	345	56	10	N(.02)	145	10	75	4
109	350	62	5	N(.04)	115	10	90	5
110	344	53	10	N(.02)	50	5	60	3
111	340	48	10	N(.02)	195	5	80	4
112	342	50	5	N(.04)	50	5	85	3
113	---	163	Ins.	---	205	5	45	2
114	---	164	Ins.	---	175	10	40	2
115	351	63	2	N(.1)	30	-5	75	3
116	341	49	5	N(.04)	25	5	60	2
117	343	51	10	N(.02)	40	5	60	2
118	337	42	5	N(.04)	50	10	80	4
119	352	64	5	N(.04)	65	5	130	4
120	338	43	5	N(.04)	20	5	35	2
121	336	41	5	N(.04)	140	10	115	4
122	335	40	10	N(.02)	100	5	80	5
123	339	45	2	N(.01)	40	5	85	4
124	334	39	5	N(.04)	90	5	60	3
125	333	38	5	N(.04)	50	10	60	3
126	332	36	5	N(.04)	65	5	80	3
127	617	DR-64-570	5	.04	150	5	50	---
128	667	571	1	N(.2)	300	15	60	---
129	666	567	5	.2	180	--	140	---
130	618	573	10	.02	150	20	95	---
131	613	563	10	.4	100	5	115	---
132	614	564	2	.7	140	5	85	---
133	619	575	5	N(.04)	100	10	50	---
134	615	566	2	N(.1)	90	10	70	---
135	624	580	2	N(.1)	170	45	100	---
136	623	579	5	N(.04)	110	10	75	---
137	622	578	5	.08	170	20	70	---
138	621	577	2	N(.1)	80	15	80	---
139	620	576	5	.06	170	25	90	---
140	612	561	2	2.0	180	25	120	---
141	609	553	10	.08	200	5	125	---
142	628	584	10	N(.02)	100	5	70	---
143	629	585	2	N(.1)	90	10	70	---
144	630	586	2	N(.1)	80	5	75	---
145	665	556	1	N(.2)	140	15	115	---

Table 1.--Gold and base-metal content of stream sediments--Continued

Map No. (fig. 2)	Sample No.		Sample weight (g)	Concentration (ppm)				
	Laboratory	Field		Au	Cu	Pb	Zn	Mo
146	664	DR-64-555	1	N(0.2)	300	25	210	---
147	610	557	5	1.2	150	5	70	---
148	611	558	5	2.4	130	20	120	---
149	606	548	10	.04	200	5	240	---
150	605	547	2	N(.1)	225	10	135	---
151	607	550	5	N(.04)	90	5	110	---
152	663	551	2	2.7	150	20	145	1
153	608	552	2	N(.1)	250	15	125	---
154	632	588	10	N(.02)	50	5	60	1
155	633	589	10	N(.02)	50	5	65	---
156	634	591	10	N(.02)	80	5	65	---
157	597	532	2	N(.1)	50	5	90	---
158	660	529	2	N(.1)	400	5	75	---
159	661	530	10	.2	450	10	70	---
160	594	526	5	.4	175	10	85	---
161	595	527	2	N(.1)	55	20	85	---
162	662	531	2	N(.1)	70	15	60	---
163	330	5D-34	5	N(.04)	80	10	80	3
164	329	33	5	N(.04)	85	10	100	3
165	327	31	5	N(.04)	50	5	120	4
166	658	DR-64-524	2	.1	135	10	75	---
167	331	5D-35	10	.2	250	20	110	7
168	328	32	5	.04	115	30	125	7
169	659	DR-64-525	5	N(.04)	35	5	60	---
170	657	523	6	.06	85	15	110	---
171	656	522	5	N(.04)	40	10	70	---
172	655	521	10	N(.02)	20	5	25	---
173	592	519	2	N(.1)	55	15	65	---
174	598	534	2	N(.1)	60	10	75	---
175	590	517	5	N(.04)	55	5	75	---
176	589	516	2	N(.1)	50	20	80	---
177	599	535	2	N(.1)	70	15	45	---
178	604	543	5	N(.04)	40	10	45	2
179	515	312	5	N(.04)	40	10	85	2
180	523	339	10	.02	55	5	60	---
181	603	542	2	N(.1)	55	5	60	---
182	600	538	10	N(.02)	45	5	25	---
183	601	540	10	N(.02)	65	5	60	---
184	602	541	5	N(.04)	75	15	55	---
185	377	5D-117	2	N(.1)	65	10	85	3
186	376	115	2	N(.1)	130	10	75	3
187	364	102	2	N(.1)	205	10	95	5
188	375	114	2	N(.1)	95	10	75	3
189	374	113	10	N(.02)	115	10	120	3
190	373	112	10	N(.02)	60	5	50	2
191	365	103	5	N(.04)	70	10	80	3
192	366	104	10	.02	130	10	80	5
193	367	105	5	N(.04)	115	5	85	4
194	368	106	10	N(.02)	110	10	80	4
195	369	107	5	N(.04)	160	20	115	5

Table 1.--Gold and base-metal content of stream sediments--Continued

Map No. (fig. 2)	Sample No. Laboratory	Sample No. Field	Sample weight (g)	Concentration (ppm) Au	Cu	Pb	Zn	Mo
196	372	5D-110	10	N(0.02)	120	10	125	3
197	371	109	5	N(.04)	100	5	105	3
198	370	108	10	N(.02)	150	15	115	3
199	627	DR-64-583	10	N(.02)	110	20	65	---
200	626	582	5	N(.04)	180	55	105	---
201	625	581	2	.85	250	20	100	---
202	407	5D-150	10	.02	90	5	80	2
203	631	DR-64-587	5	N(.04)	80	10	55	---
204	524	343	10	N(.02)	135	5	80	2
205	408	5D-151	2	N(.1)	230	10	165	3
206	410	153	10	N(.02)	125	10	115	2
207	409	152	10	N(.02)	105	5	95	3
208	411	155	Ins.	---	105	5	115	3
209	412	157	5	N(.04)	125	5	95	3
210	158	ACH-158	10	N(.02)	150	N(10)	N(200)	N(2)
211	157	157	10	N(.02)	200	N(10)	N(200)	N(2)
212	413	5D-158	5	N(.04)	75	5	90	2
213	388	129	5	N(.04)	80	5	140	3
214	389	130	10	N(.02)	30	5	95	3
215	390	132	10	N(.02)	110	10	185	4
216	378	118	5	.04	95	10	65	2
217	379	119	2	N(.1)	100	5	80	2
218	381	122	10	N(.02)	115	10	120	2
219	382	123	5	N(.04)	125	15	100	2
220	383	124	5	N(.04)	125	10	90	2
221	380	121	5	N(.04)	185	10	110	2
222	384	125	10	N(.02)	115	10	95	3
223	385	126	5	N(.04)	80	5	80	2
224	386	127	2	N(.1)	120	5	80	2
225	387	128	10		55	5	65	2
226	510	6D-328	10	N(.02)	190	5	75	2
227	509	327	5	N(.04)	40	5	55	2
228	497	315	2	N(.1)	30	5	55	1
229	501	319	5	N(.04)	35	10	90	2
230	506	324	2	N(.1)	105	5	65	2
231	507	325	2	N(.1)	45	5	80	3
232	186	ACH-186	10	N(.02)	50	N(10)	N(200)	N(2)
233	184	184	10	N(.02)	100	10	N(200)	N(2)
234	185	185	2	N(.1)	150	10	N(200)	N(2)
235	398	5D-140	10	N(.02)	85	10	120	3
236	391	133	5	N(.04)	70	5	40	2
237	397	139	2	N(.1)	95	15	150	2
238	392	134	10	N(.02)	45	5	90	2
239	187	ACH-187	2	N(.1)	150	N(10)	N(200)	N(2)
240	393	5D-135	2	N(.1)	50	5	85	2
241	396	138	2	N(.1)	210	20	220	5
242	395	137	10	N(.02)	85	10	140	3
243	394	136	10	N(.02)	60	10	80	2
244	188	ACH-188	10	N(.02)	100	N(10)	N(200)	N(2)
245	189	189	10	N(.02)	100	10	N(200)	N(2)

Table 1.--Gold and base-metal content of stream sediments--Continued

Map No. (fig. 2)	Sample No.		Sample weight (g)	Concentration (ppm)				
	Laboratory	Field		Au	Cu	Pb	Zn	Mo
246	190	ACH-190	2	N(0.1)	100	20	N(200)	N(2)
247	191	191	10	.04	150	15	N(200)	N(2)
248	325	5D-24	5	N(.04)	40	5	60	3
249	406	149	10	.1	180	5	50	4
250	405	148	10	N(.02)	145	5	95	3
251	403	146	5	.02	175	5	90	4
252	402	145	10	.02	160	5	105	2
253	404	147	5	N(.04)	285	5	90	4
254	401	144	5	.2	130	10	85	3
255	400	143	5	.04	135	10	130	3
256	399	141	10	.04	280	35	200	5
257	---	DR-64-429	Ins.	---	350	250	250	13
258	---	313	Ins.	---	60	20	235	4

Table 2.--Gold content of rocks

[Only rocks containing 0.02 ppm or more gold are listed. Analysts (atomic absorption): M. S. Rickard, W. L. Campbell, and R. L. Miller]

Map No. (fig. 2)	Sample No.		Concentration (ppm)	Description of rocks
	Laboratory	Field	Au	
R40	ACH-739	5D-32	0.04	Hornblende-feldspar porphyry dike.
R50	679	63-A-76A	.06	Hornblende-feldspar porphyry dike with disseminated pyrite.
R51	681	77A	.02	Porphyritic hornblende diorite with disseminated pyrite.
R53	720	DR-64-320	.02	Hornblende-feldspar porphyry dike, highly epidotized.
R54	721	322	.02	Hornblende-biotite diorite.
R55	723	324	.02	Hornblende-feldspar porphyry dike.
R60	685	63-A-606	.3	Hornblende diorite with minor disseminated pyrite.
R78	727	DR-64-332	.02	Hornblende diorite with disseminated pyrite.
R85	731	336	.02	Hornblende diorite.
R102	763	5D-134	.02	Quartz diorite with disseminated pyrite.
R104	761	131	.04	Hornblende-quartz diorite with disseminated pyrite.

Table 3.--Concentration of gold and base metals

Element	Concentration (ppm)				
	Crustal Average[1]	Slana area			
		Rock[2]			Stream sediments[3]
		Range	Mean	Mode	Mode
Gold ---------	0.004	<0.02-.3	---	---	<0.02
Copper--------	55	5-250	47	10-20	40-50
Lead----------	12.5	5-35	10	10	10
Zinc----------	70	15-140	68	50-60	60-70
Molybdenum----	1.5	1-5	2	3	2.5

[1]After Taylor (1964).

[2]Gold based on 105 samples (this report); copper, lead, zinc, and molybdenum based on 34 samples (Richter, 1966).

[3]Based on 384 samples (Richter, 1966) including the 258 samples for which data are presented in this report.

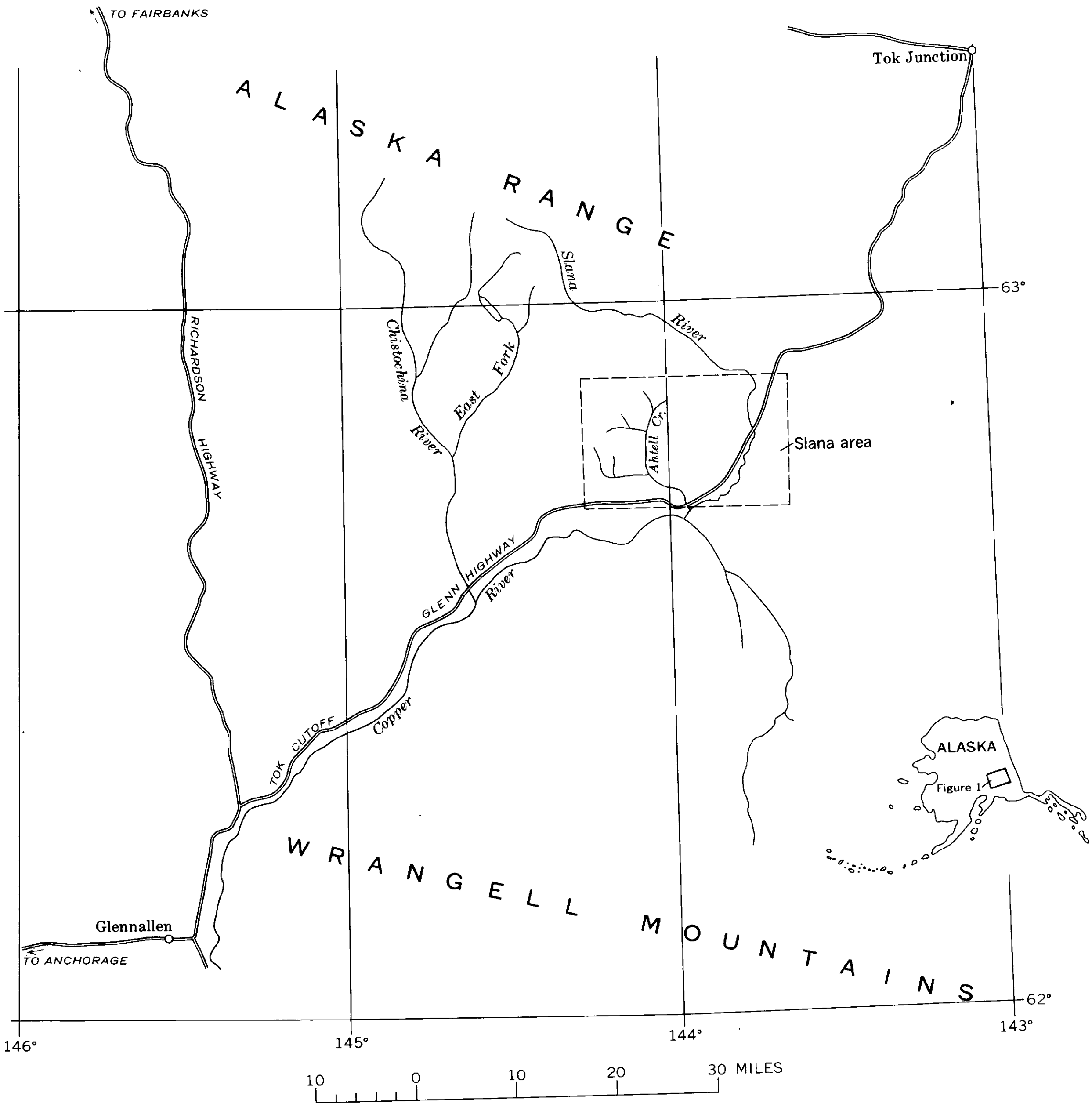
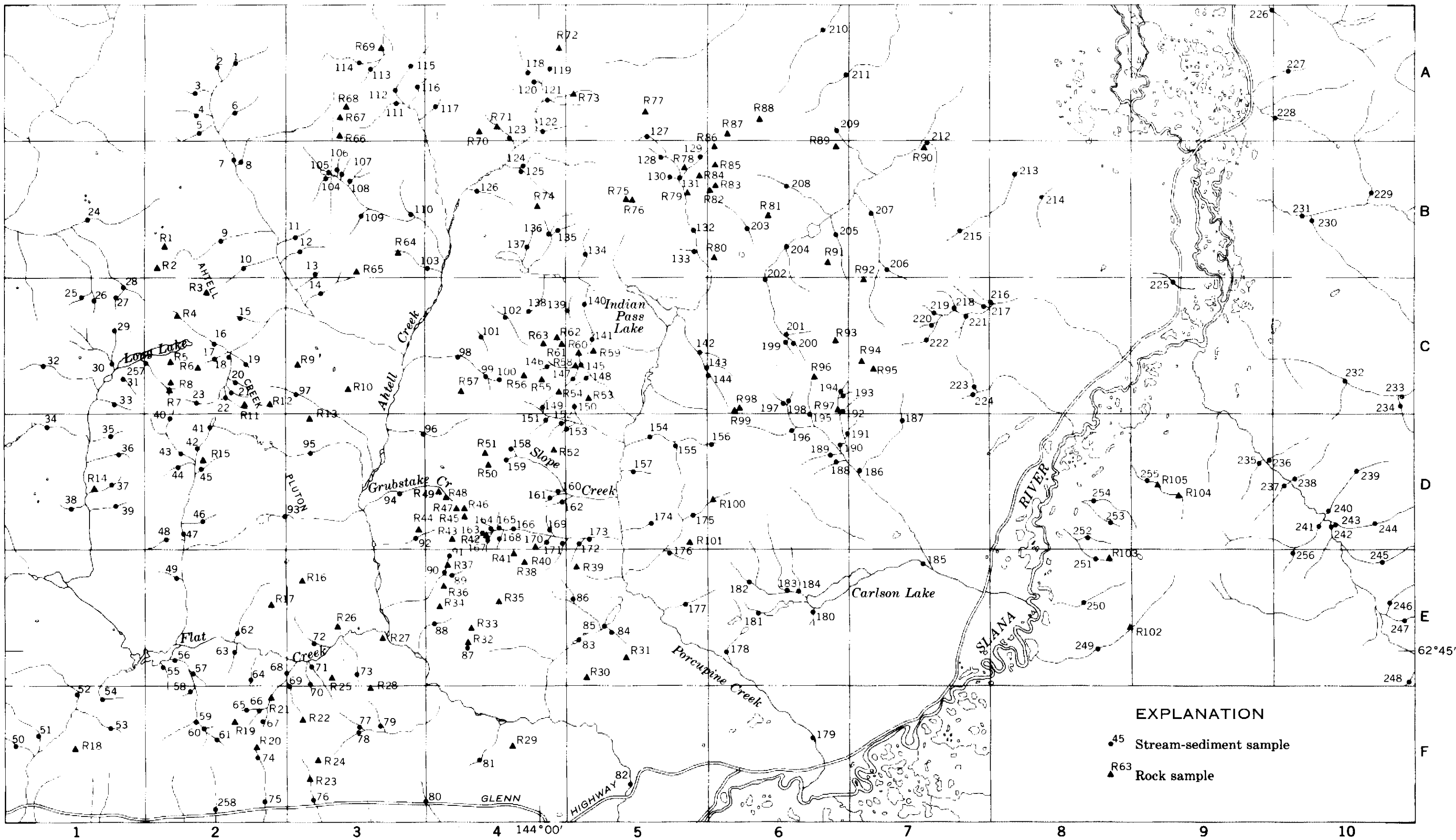


Figure 1.--Index map of part of south-central Alaska showing the Slana area.



Base from U.S. Geological Survey, 1:63,360.
Gulkana C-1, 1949, D-1, 1952; Nabesna C-6, 1948, D-6, 1949

Figure 2.--Sample-location map, Slana area.

EXPLANATION

GOLD AND BASE-METAL DISTRIBUTION MAPS

UNCONSOLIDATED DEPOSITS

Qsd — **Surficial deposits** — QUATERNARY
Stream, glacial, landslide, and talus deposits

BEDDED ROCKS

KJa — **Argillite, siltstone, graywacke, and conglomerate** — JURASSIC AND CRETACEOUS

PIPvs — **Andesitic volcanic rocks, limestone and argillite, and amygdaloidal basalt with intercalated limestone** — PENNSYLVANIAN(?) AND PERMIAN

INTRUSIVE ROCKS — JURASSIC(?)

Jqm — **Quartz monzonite and granodiorite**
Includes irregular fine-grained silicified border zone around Ahtell Creek pluton in west part of area

Jd — **Diorite, quartz diorite, gabbro, and anorthosite**

Limit of bedrock exposure

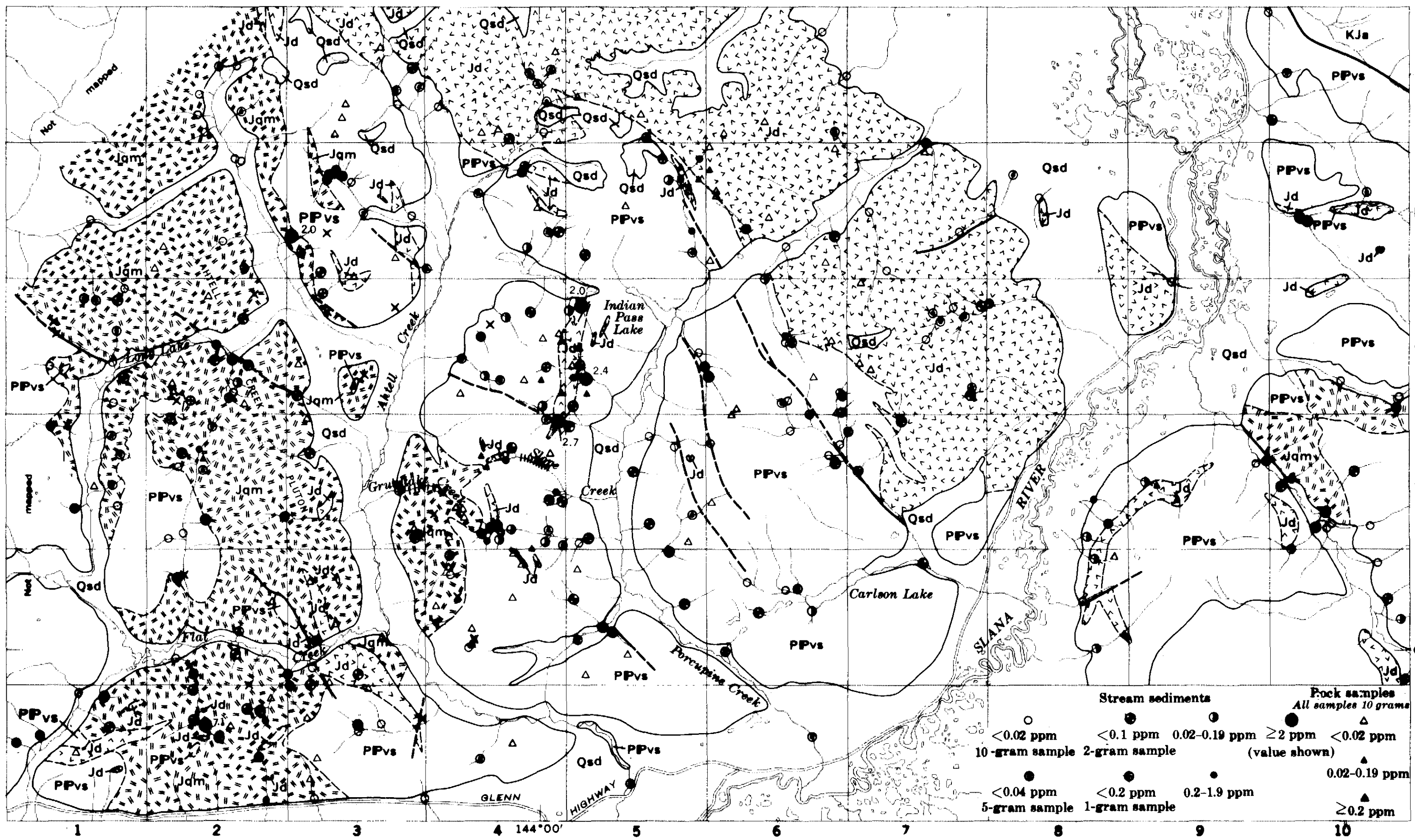
Approximate contact

Fault
Dashed where inferred

Gold placer workings

× Silver and base-metal quartz vein

Figure 3.--Explanation for geologic maps showing distribution of gold and base metals (figs. 4-8).



Base from U.S. Geological Survey, 1:63,360. Gulkana C-1, 1949, D-1, 1952; Nabesna C-6, 1948, D-6, 1949

Geology by D. H. Richter, 1963-67 and N. A. Matson, Jr., 1967

Figure 4.--Map showing distribution of gold in the Slana area.

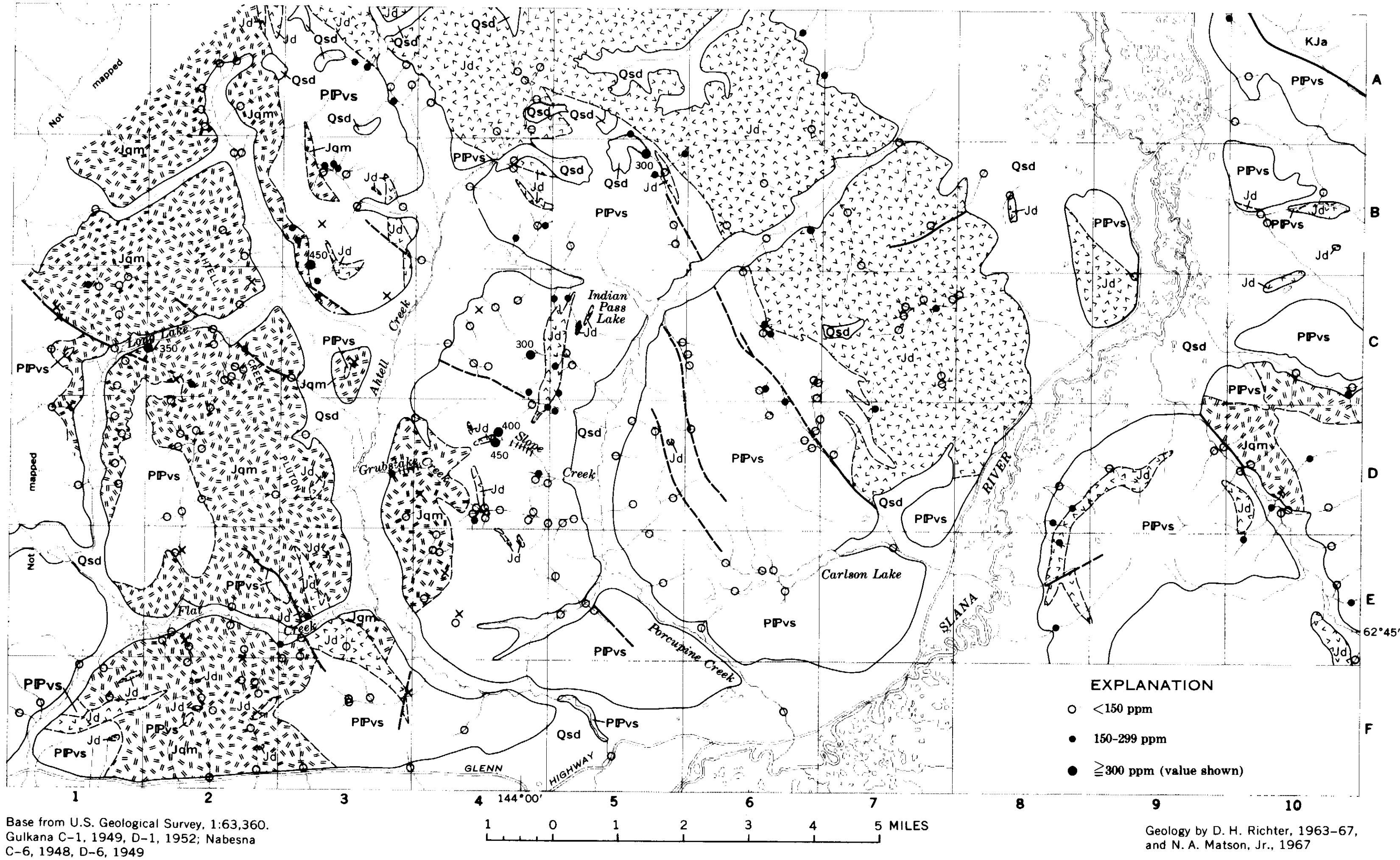
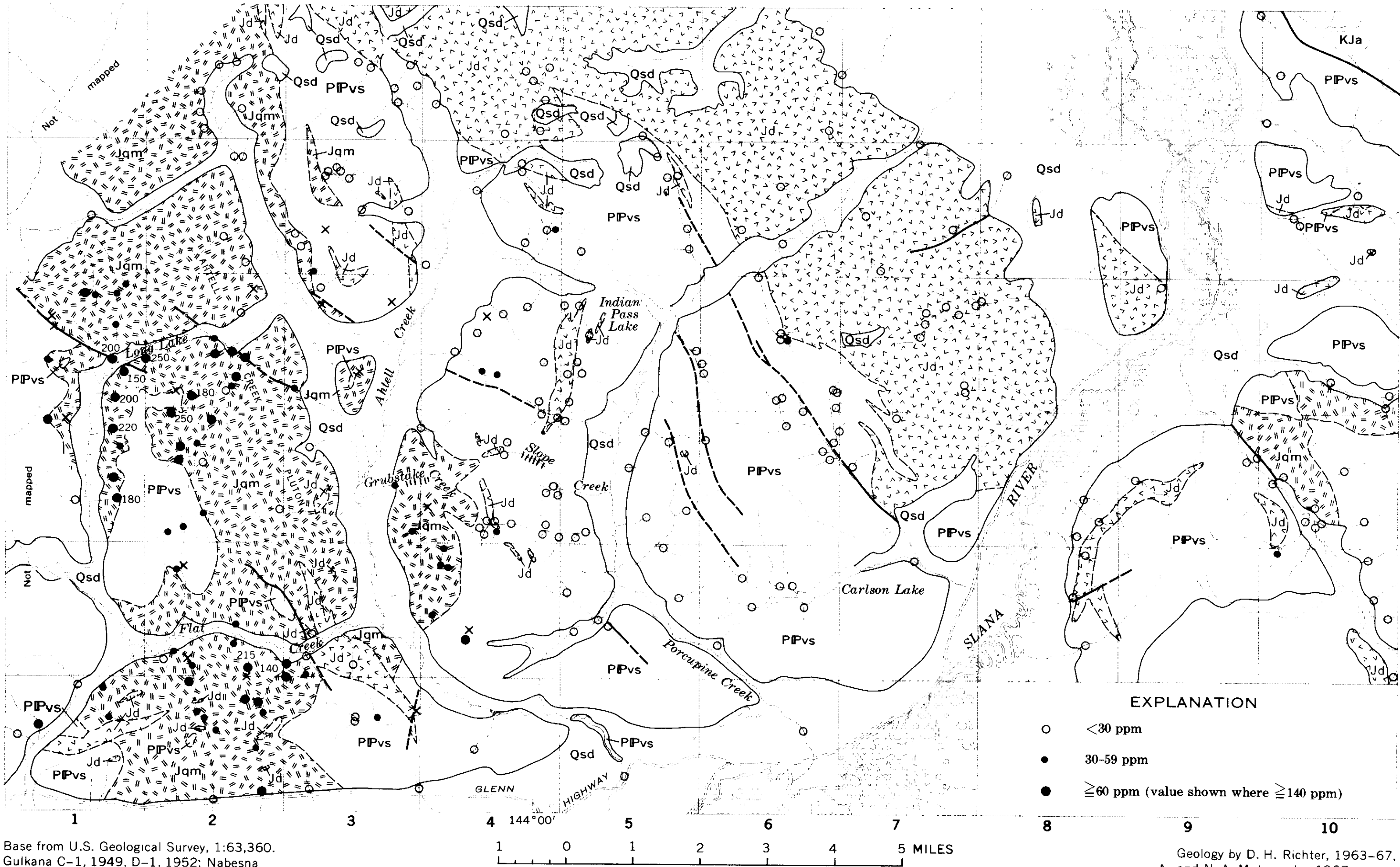


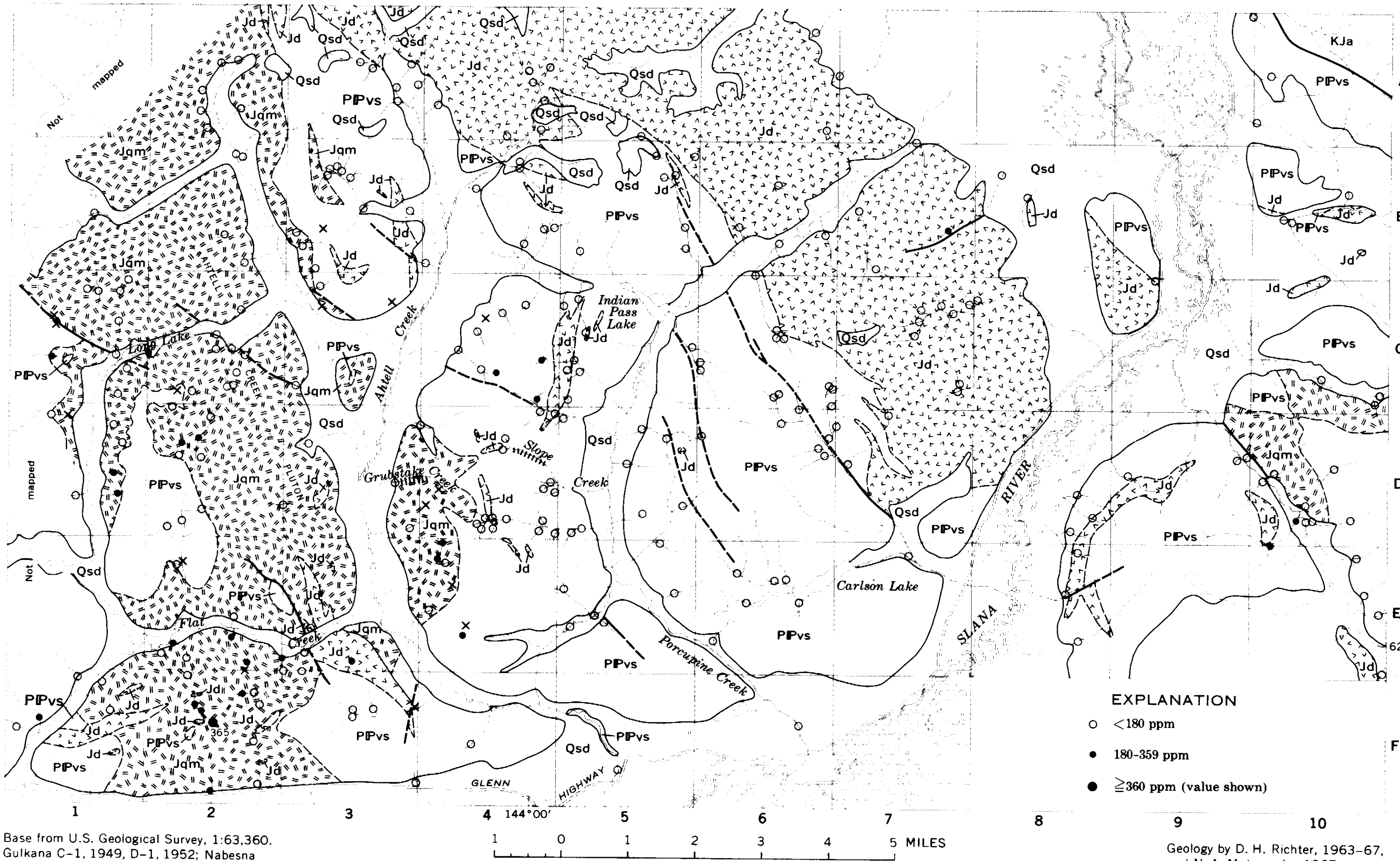
Figure 5.--Map showing distribution of copper in the Slana area.



Base from U.S. Geological Survey, 1:63,360. Gulkana C-1, 1949, D-1, 1952; Nabesna C-6, 1948, D-6, 1949

Geology by D. H. Richter, 1963-67, and N. A. Matson, Jr., 1967

Figure 6.--Map showing distribution of lead in the Slana area.



Base from U.S. Geological Survey, 1:63,360. Gulkana C-1, 1949, D-1, 1952; Nabesna C-6, 1948, D-6, 1949

Geology by D. H. Richter, 1963-67, and N. A. Matson, Jr., 1967

Figure 7.--Map showing distribution of zinc in the Slana.

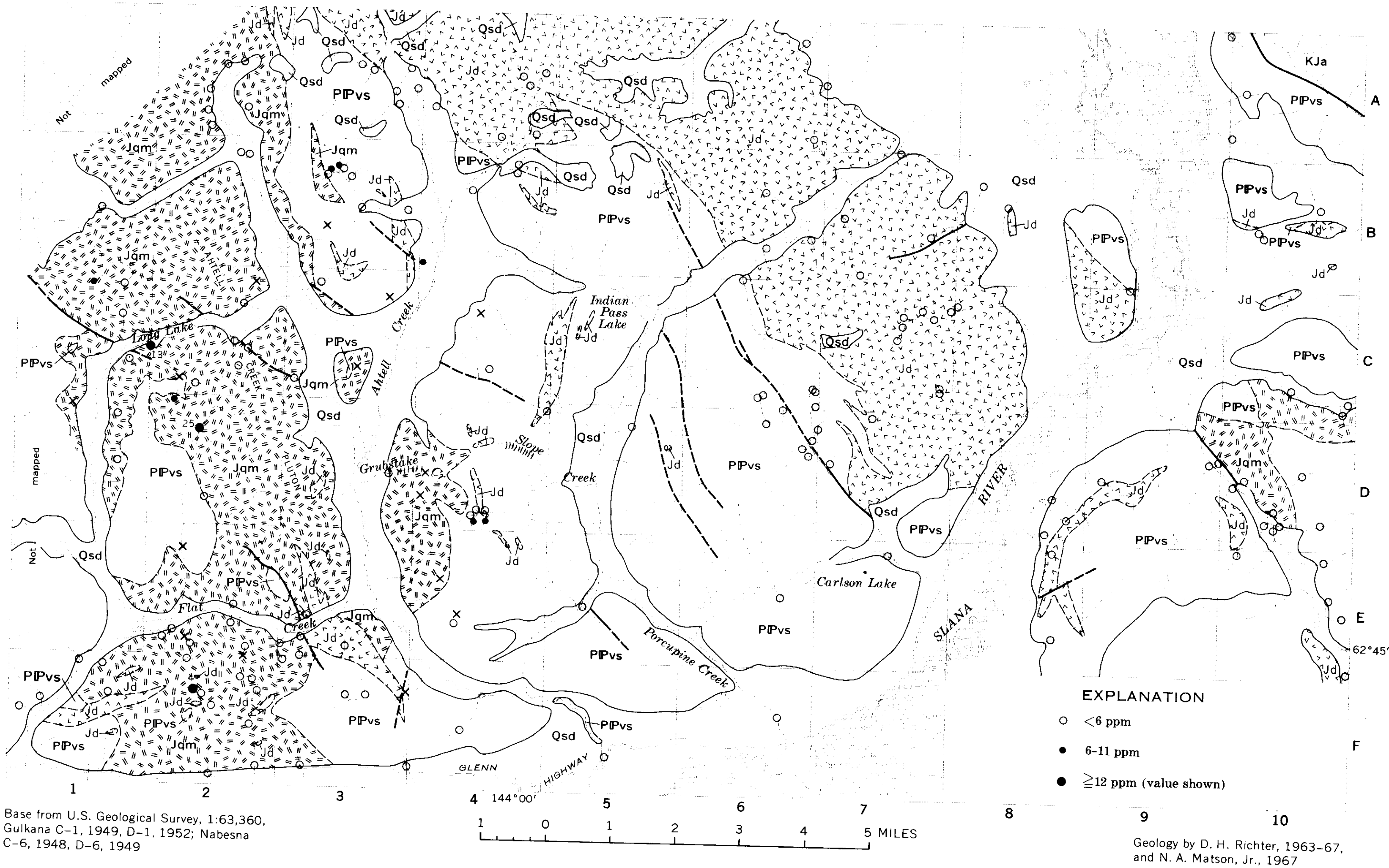


Figure 8.--Map showing distribution of molybdenum in the Slana area.