GEOLOGICAL SURVEY CIRCULAR 617

Results of Geological and Geochemical Investigations in an Area Northwest of the Chulitna River Central Alaska Range

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Abstract

Sedimentary and volcanic rock units of Paleozoic and Mesozoic age, faults, and elongate bodies of intrusive rock, particularly serpentinites, have a dominant northeasterly trend in an area northwest of the Chulitna River between Eldridge Glacier and Bull River. The serpentinites locally contain abnormal (as much as 0.5 percent) concentrations of nickel, have one newly identified occurrence of chromite, and are hosts to small epigenetic lodes containing copper, gold, and silver. Other epigenetic concentrations of copper or other metals occur in interlayered basalt and limestone at Partin and Canyon Creeks in the southwestern part of the area and in porphyry near Costello Creek in the northern part of the area. Tin occurs in greisen on upper Ohio Creek, and abnormal concentrations of tin also characterize mineralized rocks along Canyon Creek and at a prospect near Long Creek. Mineralized rocks characterized by silver, lead, and zinc crop out near Lookout Mountain.

Anomalous concentrations of gold and other metals occur in stream sediments at isolated sites in upper Long Creek and at Coal Creek, as well as in several areas near known lode mineral occurrences. Shotgun and McCallie Creeks both contain stream sediments with anomalous concentrations of metals and both head into the basalt-limestone unit which is the host rock at Partin and Canyon Creeks; these facts suggest that other concentrations may be found.

INTRODUCTION

A mineralized area near the West Fork of the Chulitna River has been known since the early 1900's (Capps, 1919; Ross, 1933). The area, called the Upper Chulitna district (fig. 1), includes the Golden Zone mine and Silver King and Copper King prospects which were investigated by the U.S. Geological Survey in 1967 (Hawley and Clark, 1968).

The aim of the investigations in 1968 was to extend geologic mapping and geochemical sampling to areas adjacent to the Upper Chulitna district; this report summarizes geologic findings and emphasizes results that may have economic significance. The main contributions are the recognition of rocks containing unusual concentrations of copper, silver, tin, and other metals at several places and the identification of a belt containing bodies of alpine-type serpentinite. The main copper-bearing localities are near Partin, Canyon, and Costello Creeks; silver is characteristic of rocks near Lookout Mountain; tin is found in greisen in upper Ohio Creek and with arsenopyrite at Canyon Creek.

The report also summarizes the results of stream-sediment sampling; the data are supplemented by a series of geochemical maps in a U.S. Geological Survey open-file report (Hawley and Clark, 1969).

GEOLOGIC SETTING

The Upper Chulitna district and adjoining areas have a strong northeasterly structural grain shown by the orientation of rock layers, folds, and faults, and by the elongation of intrusive bodies of igneous rock (fig. 1).

Layered rocks of Paleozoic and Mesozoic age predominate, but coal-bearing rocks of Tertiary age crop out in the Costello Creek coal fields in the northeastern part of the mapped area (fig. 1). The pre-Tertiary layered rocks can be divided into four main units. The oldest rocks, principally siliceous argillite and interlayered graywacke-argillite, crop out in the southeastern part of the area. They are overlain with angular unconformity by a sequence of red beds and limestones that grade upward into argillite. The red beds contain much volcanic material. Ross (1933, p. 298 and 300) assigned the red beds to the Carboniferous, probably Permian, and the limestones to the Upper Triassic. In some areas a unit of basalt, subordinate mafic intrusive rock, and bedded chert lies

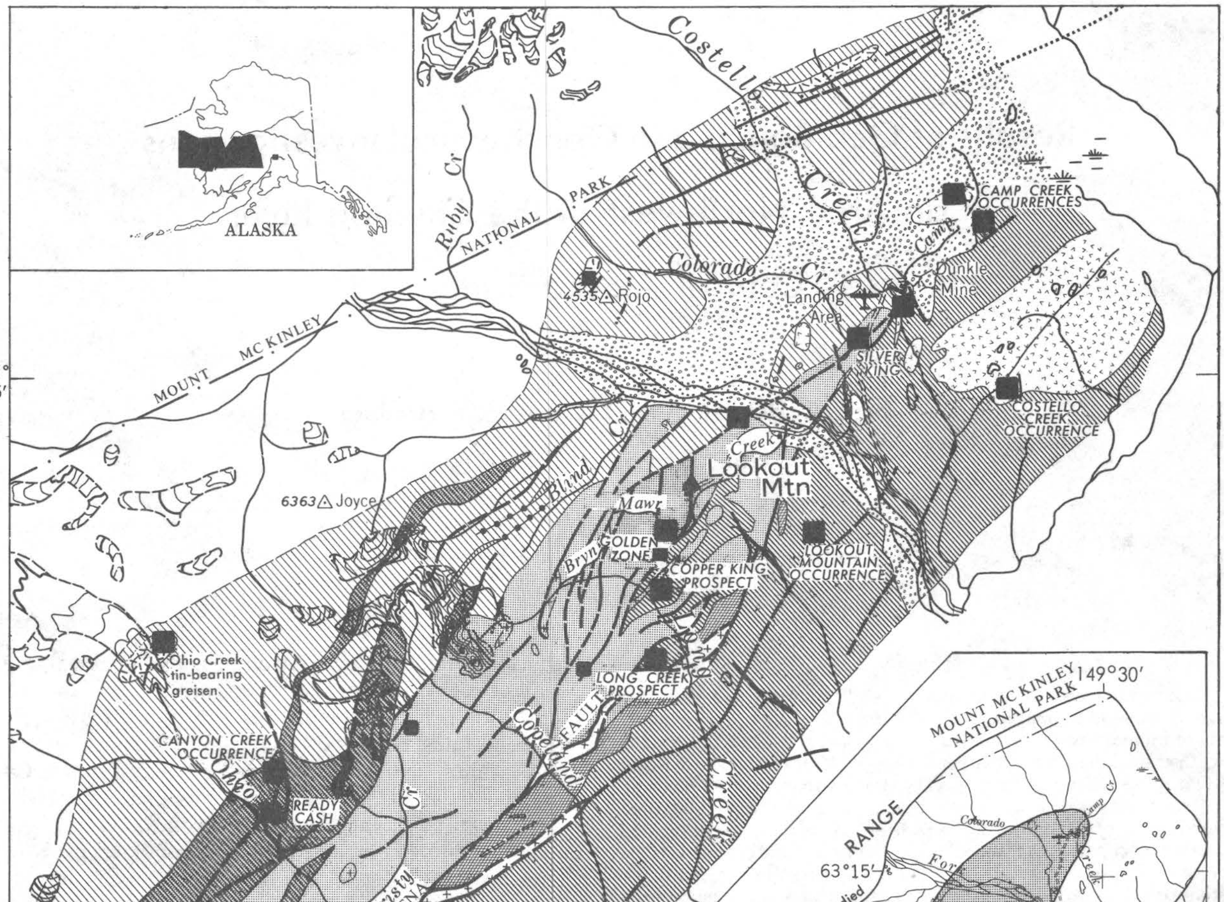

Figure 1.—Generalized geologic map showing the location of mineral deposits and occurrences in the Upper Chulitna district and an area northwest of the Chulitna River, central Alaska Range.

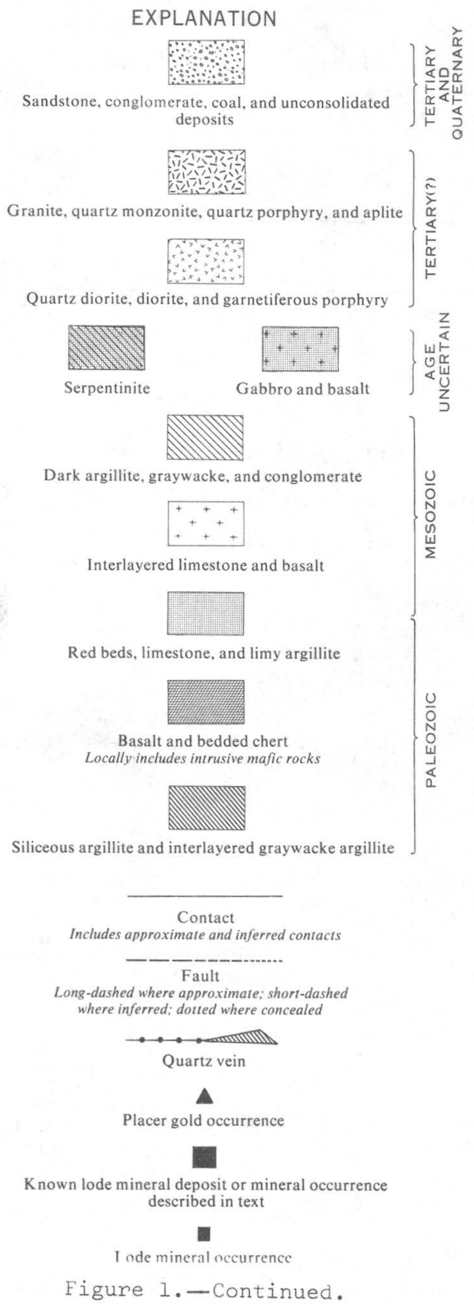

Figure 1.—Continued.

between the argillite-graywacke unit and the red beds. Overlying the argillite in the red-bed and limestone unit is a distinctive unit of interlayered limestone and basalt which apparently thickens southward. The uppermost unit is composed of dark-colored detrital rocks—argillite, graywacke, and conglomerate. A pelecypod, *Buchia sublaevis* (Imlay, not Keyserling), collected from the dark-colored detrital sequence near upper Costello Creek is of Early Cretaceous age (David L. Jones, written commun., 1968).

The layered sedimentary and volcanic rocks are highly folded and faulted. The folds (not shown in fig. 1) are asymmetric anticlines and synclines with northwest-dipping axial planes. Fold axes generally plunge northeastward.

The sedimentary and volcanic rocks of the area are cut by igneous bodies which are ultramafic to granitic in composition. Serpentinite and gabbro are found in a belt along the southeast flank of the area. Granite and porphyry of intermediate composition occur in stocks and numerous bodies too small to show, particularly in the northern part of the area. The igneous rocks were emplaced after folding and some faulting, but before the deposition of the coal-bearing beds of Tertiary age.

Faults, including a complex zone called the Upper Chulitna fault (fig. 1), also trend northeasterly; most are high angle. The Upper Chulitna fault and subsidiary subparallel faults controlled the emplacement of masses of serpentinite and fine-grained gabbro. A second major fault separates the red-bed, limestone, and argillite unit from the interlayered basalt and limestone in the southwest part of the area.

GEOLOGIC STUDIES OF MINERAL DEPOSITS AND OCCURRENCES

The mineral deposits or occurrences of the area comprise syngenetic or nearly syngenetic bodies of chromite and nickel-bearing minerals and epigenetic bodies containing copper, arsenic, gold, and other metals. Chromium and nickel occur in serpentinized ultramafic rocks; epigenetic bodies occur in several host rocks.

The epigenetic deposits and occurrences are distributed widely but are more numerous and larger in the area north of Long Creek (fig. 1). That area contains the known deposit at the Golden Zone mine and the prospects at Silver King and Copper King. Other occurrences include the Long Creek prospect and the ones at Costello Creek and Lookout Mountain (fig. 1). Another zone where epigenetic occurrences seem to be relatively numerous extends northeastward from south of Partin Creek to Canyon Creek in the southwest part of the area.

SYNGENETIC OCCURRENCES IN SERPENTINITE

A discontinuous belt of alpine-type serpentinite bodies can be traced about 25 miles northeastward from Eldridge Glacier to just south of the Dunkle coal mine (figs. 1 and 2). Individual bodies are as much as 1,000 feet thick and can be traced for more than 4 miles; the largest masses are in the Upper Chulitna fault zone. The serpentinite is interesting economically because locally it contains anomalous amounts of nickel, chromium, copper, and gold (table 1).

The serpentinite bodies include dark-green to black massive serpentinite, sheared serpentinite and soapstone, and pale- to dark-greenish-brown quartz-carbonate rock formed by alteration of serpentinite. Most serpentinite samples contain 1,000–3,000 ppm

Table 1.—*Analyses of serpen-*

[Analysts: Joe Curry, R. L. Miller, Buryl Wescott, Richard Tripp, Harriet Neiman, C. L. Forn. Riley, W. D. Goss, and Joseph Haffty. Determination of Fe and Cr on sample 10 by Claude given in percent. Analyses, unless noted, are semiquantitative spectrographic and are re- ing symbols: N, not detected; L, detected but below limit of determination; ---, not looked tion, limit of determination shown in parentheses: Be (1), Bi (10), Cd (20), La (20), Sb 14 (ACL035) and 100 ppm in 18 (AGJ602); Cd, 300 ppm in 18 (AGJ602); La, 20 ppm in 1 (AGJ878) shown in figure 2]

Sample No.	Lab. No.	Field No.	Ag	As	Au[1]	B	Ba	Co	Cr	Cu	Hg[2]	Mo	Mn	Nb
1	AGJ876	S11—H6A	N	N	N	L	70	50	500	[1]750	---	N	1,000	L
	877	H6B	N	N	N	30	N	70	2,000	20	---	N	500	L
	878	H6C	15	N	.1	30	100	200	20	[1]75,000	---	15	15	L
	879	H6D	1	L	.04	30	100	150	150	[1]20,000	---	L	300	L
	880	H6E	.7	N	.02	N	50	5	10	[1]120	---	L	15	L
2	835	ACK293	N	N	N	50	70	150	1,500	L	---	L	700	L
	837	294	N	N	.02	L	50	70	1,500	10	---	L	700	L
3	846	299	N	N	N	L	1,500	50	1,000	150	---	N	1,500	L
	847	301	N	N	N	L	L	50	2,000	7	---	N	2,000	L
4	848	304	N	N	N	30	L	150	2,000	15	---	N	700	L
5	843	ACS811	N	N	N	N	L	50	3,000	7	---	N	1,500	L
6	844	818	N	N	N	L	150	7	30	7	---	N	1,000	L
7	830	CK279	L	N	.06	10	70	50	1,500	200	---	5	1,500	L
	831	279A	.7	L	.04	L	1,000	70	1,500	70	---	L	2,000	L
	832	282	.7	N	.04	20	50	N	300	7,000	---	7	3,000	L
8	840	ACS801	N	N	N	N	L	70	3,000	70	---	N	700	L
	841	802	N	N	N	200	L	500	>5,000	5	---	N	1,000	L
	842	803	N	N	N	L	L	150	3,000	7	---	N	1,000	L
9	874	S6-H50A	N	N	N	50	N	200	>5,000	20	---	L	700	L
	875	B	N	N	N	20	50	70	5,000	50	---	N	700	L
10	ACL536	M824	N	N	---	20	100	100	[3]27	2	---	N	2,000	N
11	901	ACK207A	N	N	N	L	300	50	1,500	70	---	N	300	L
	902	207B	N	N	N	150	N	150	2,000	10	---	N	300	L
	903	207C	N	N	N	70	N	150	2,000	7	---	N	300	L
	904	207E	N	N	N	70	N	150	2,000	15	---	N	300	L
	905	207F	N	N	N	15	N	100	150	L	---	5	2,000	10
	906	207G	N	N	N	10	N	30	150	7	---	N	1,000	L
	AGJ210	ACK210	N	N	.06	20	70	70	2,000	L	---	L	700	L
12	801	201	L	N	.3	20	70	150	1,500	3,000	---	10	500	L
13	803	205	N	N	.02	L	L	70	1,500	10	---	N	700	L
14	ACL035	67HX263	N	300	N	10	20	50	1,500	100	---	N	1,000	L
	037	HX329A	N	N	N	70	5	150	3,000	20	---	N	700	L
	036	HX327	N	N	.02	50	30	5	150	30	---	N	1,000	N
15	ACF063	67AHX177	N	N	N	30	N	100	2,000	5	---	N	700	N
16	ACE614	67HX227	N	N	N	20	N	100	5,000	L	---	L	1,500	30
17	AGJ615	SK40	N	N	N	500	N	200	3,000	20	0.03	N	700	L
	616	SK40B	N	N	N	150	N	200	5,000	50	.01	N	3,000	L
18	601	SK—7	N	L	N	300	N	100	2,000	100	.06	N	700	L
	604	SK—11	.7	300	.02	200	N	150	1,500	30	.08	N	500	L
	602	SK—8	500	>10,000	6.6	30	70	L	15	2,000	2.0	N	15	10
Limits of determination-----			0.5	200	0.02	10	5	5	5	5	0.01	5	10	10

[1] Atomic absorption.
[2] Specific instrumental or chemical method.
[3] Given in percent.

Fire assay and quantitative spectrographic analyses for platinum-group metals by L. B. Huffman, Jr. Results are given in parts per million except Fe, Mg, Ca, and Ti, which are ported in the series 0.1, 0.15, 0.2, 0.3, 0.5, 0.7, 1.0, 1,5, and so on, or by the follow- for; H, interference. Looked for but not detected or detected but below limit of determina- (100), Sn (10), and W (50). Exceptions are (lab numbers in parentheses): Bi, 10 ppm in sample and 1 (AGJ879); Sb, 3000 ppm in 18 (AGJ602); and Sn, 10 ppm in 7 (AGJ832). Sample numbers are

Ni	Pb	Pd[2]	Pt[2]	Rh[2]	Sc	Sr	V	Y	Zn	Zr	Fe	Mg	Ca	Ti
150	L	---	---	---	30	200	150	20	200	30	7	3	5	0.2
1,500	L	---	---	---	15	N	30	L	L	N	7	10	L	.03
50	10	---	---	---	5	N	70	L	200	L	20	.3	L	.05
70	L	---	---	---	20	N	200	15	200	20	20	2	.05	.2
L	15	---	---	---	5	N	15	10	L	20	3	.05	N	.2
2,000	N	<0.004	<0.01	<0.005	5	N	30	L	N	L	7	10	L	.01
1,500	10	<.004	<.01	<.005	7	70	30	L	N	L	5	10	3	.005
150	L	---	---	---	70	150	300	10	N	30	10	7	7	.7
1,500	L	---	---	---	5	300	30	L	L	L	5	7	7	.03
3,000	L	---	---	---	7	L	30	L	L	L	10	>10	.3	H
1,500	L	---	---	---	7	300	30	N	N	L	7	7	3	L
30	L	---	---	---	7	N	70	N	N	50	10	.7	.05	.15
700	L	.005	<.01	<.005	15	70	150	15	L	50	7	7	5	.5
1,000	L	<.004	<.01	<.005	10	150	70	10	L	20	7	7	10	.15
100	L	---	---	---	20	N	200	15	L	30	15	7	.07	.3
1,500	L	---	---	---	5	N	N	N	N	L	7	7	1	.007
2,000	L	---	---	---	L	N	20	N	L	L	15	10	.15	.002
1,500	L	---	---	---	15	N	30	N	N	L	N	10	.7	.005
5,000	N	---	---	---	10	N	50	N	L	N	10	>10	L	.007
1,500	L	---	---	---	10	L	70	10	L	30	7	5	1	.15
1,000	N	<.004	<.01	.019	7	10	700	N	N	N	[1]9.1	>10	0.7	0.07
150	N	---	---	---	30	200	150	L	N	30	3	3	.3	.15
1,500	N	---	---	---	7	N	20	N	N	N	3	7	L	.003
1,500	N	---	---	---	5	N	15	N	N	N	3	10	L	.005
1,500	N	---	---	---	L	N	15	N	N	N	3	7	L	.003
100	L	---	---	---	30	1,500	300	30	N	70	10	2	2	.3
200	N	---	---	---	L	N	15	N	N	N	2	L	L	.007
1,000	N	---	---	---	5	150	10	N	N	N	3	3	>20	L
1,500	N	<.004	<.01	<.005	7	70	15	N	200	N	20	7	.7	.005
1,500	N	.004	<.01	<.005	5	300	10	N	N	N	3	7	5	L
1,500	L	---	---	---	5	N	L	N	N	N	7	7	.5	.01
2,000	N	---	---	---	10	N	L	N	N	N	10	>10	.07	<.001
50	L	---	---	---	5	150	30	N	N	L	1.5	10	20	.1
1,000	N	---	---	---	10	N	15	N	N	N	5	7	.7	.007
1,500	L	---	---	---	5	N	15	N	N	N	10	7	.5	.003
5,000	N	---	---	---	5	L	15	N	L	N	15	>10	3	L
5,000	N	---	---	---	5	L	15	N	L	N	10	>10	5	L
5,000	L	---	---	---	7	100	50	N	N	N	7	10	5	.015
5,000	10	---	---	---	7	N	10	N	N	N	15	>10	L	L
10	7,000	---	---	---	L	N	20	L	10,000	N	10	L	L	.03
5	10	0.004	0.01	0.005	5	50	10	10	200	20	0.05	0.02	0.05	0.001

Description of samples given in table 1

Sample No. shown in fig. 2	Lab. No.	Description
1	AGJ876	Malachite-stained serpentinite; staining confined to fracture surfaces.
	877	Blocky massive greenish-black serpentinite.
	878	Pyrite-rich and chalcopyrite-rich (more than 50 percent) rock; quartz matrix.
	879	Pyrite-rich (more than 50 percent) rock.
	880	Vuggy quartz.
2	AGJ835	Serpentinite.
	837	Quartz-carbonate rock. Pyrite locally abundant.
3	AGJ846	Serpentinized basalt cut by jasperoid veinlets.
	847	Altered ultramafic rock, chiefly quartz-carbonate rock; vuggy.
4	AGJ848	Highly sheared serpentinite.
5	AGJ843	Limonite-stained quartz-carbonate rock which forms a 75-foot-wide zone between serpentinite and basalt.
6	AGJ844	20- to 30-foot-wide serpentinite with local quartz-carbonate zones.
7	AGJ830	Dark-green sheared serpentinite.
	831	Serpentinite in fault zone.
	832	Malachite-stained sheared basalt adjacent to serpentinite.
8	AGJ801	5-foot-wide zone of quartz-carbonate rock between basalt and serpentinite.
	802	Serpentinite with well-developed antigorite(?) films in veinlets and on fracture surfaces.
	803	Limonite-stained quartz-carbonate zone about 20 feet wide in serpentinite.
9	AGJ874	Greenish-black massive serpentinite.
	875	Pale-brown quartz-carbonate rock. Disseminated pyrite.
10	ACL536	Massive chromite.
11	ACL901	Altered quartz monzonite; forms the south border of serpentinite mass. Unit about 7 feet wide.
11	ACL902	Quartz-carbonate-rich serpentinite, locally massive quartz-carbonate material. Zone 3 feet wide, adjacent to ACL901.
	903	Dense black serpentinite cut by thin veinlets of sheared antigorite(?). Zone approximately 100 feet wide. Adjacent to ACL902.
	904	Serpentinite.
	905	Sheared and altered basalt. Zone about 25 feet wide. Adjacent to ACL904.
	906	Sheared fibrous material (antigorite(?)) from black serpenitinite (ACL903).
	AGJ210	Jasperoid-calcite rock from small plug in basalt. Basalt is adjacent to serpentinite.
12	AGJ801	Sheared black serpentinite, locally contains inclusions of jade(?). Disseminated pyrite, locally as much as 20 percent.
13	AGJ803	Strongly sheared and silicified serpentinite.
14	ACL035	Sheared serpentinite.
	037	Strongly sheared, greenish-black serpentinite in a fault zone.
	038	Pale-gray bleached brecciated basalt.
15	ACF063	Brownish-white altered serpentinite.
16	ACE614	Dark-grey serpentinized pyroxenite, locally cut by 1/16-inch veinlets of cross-fiber mineral.
17	AGJ615	Massive to sheared greenish-black serpentinite.
	616	Same as AGJ615.
18	AGJ601	Quartz-carbonate rock.
	604	Quartz-carbonate rock.
	602	Arsenopyrite-quartz vein (Eagle vein) on hanging wall of serpentinite body. Vein as much as 1 foot wide, contains 50 percent arsenopyrite.

(parts per million) of both nickel and chromium (table 1) or approximately their normal amounts in ultramafic rocks (Turekian and Wedepohl, 1961). Locally, however, the samples contain as much as 5,000 ppm (0.5 percent) nickel and more than 5,000 ppm chromium. The rocks highest in nickel were found at localities 9, 17, and 18 in figure 2; the rocks highest in chromium, at localities 10 (massive chromite), 8, 9, 16, and 17.

The copper content of serpentinite is generally low, but epigenetic copper occurrences in serpentinite near Eldridge Glacier (locality 1, fig. 2) contain as much as 7.5 percent copper. The serpentinite at locality 1 is cut by irregular and veinlike zones of massive pyrite and chalcopyrite at least 3 feet across. Localities 7, 12, and 18 also have epigenetic occurrences of copper or silver and gold.

Massive chromite (locality 10, fig. 2) is associated with serpentinite that is locally altered to quartz-carbonate rock. The serpentinite body is lenticular and is as much as 1,000 feet across and more than 3 miles long. Locally, the quartz-carbonate rock contains disseminated pyrite and is stained with garnierite. The chromite was not found in place, but massive chromite blocks as much as a foot across were found in talus. A sample of material estimated to contain more than 95 percent chromite contains 39.5

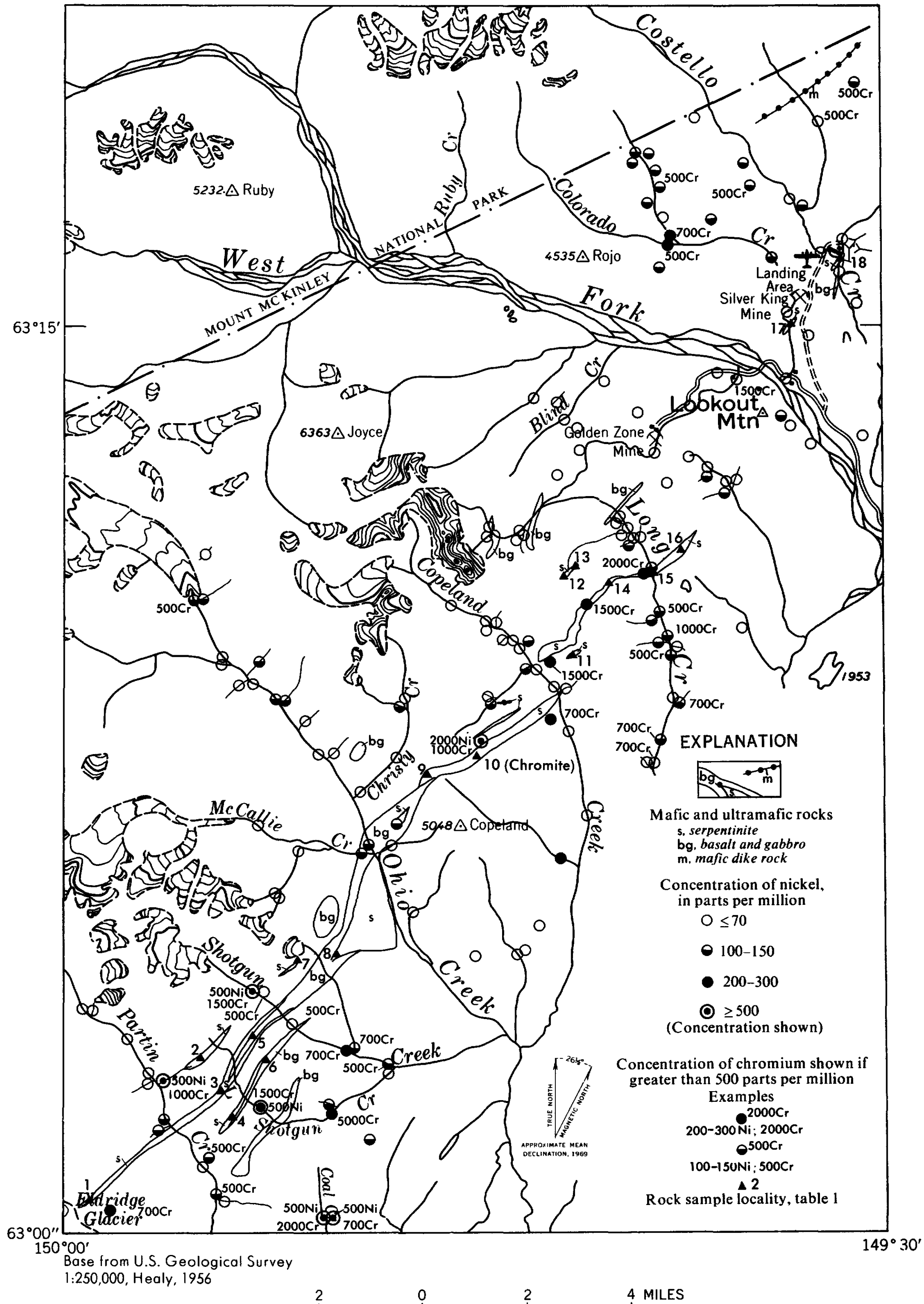

Figure 2.—Map of serpentinite belt showing concentration of nickel and chromium in stream-sediment samples and location of bedrock samples.

percent Cr_2O_3 and has a Cr_2O_3:Fe_2O_3 ratio of 3.1:1. The chromite has only a trace of platinum metals (sample 10, table 1), principally rhodium.

EPIGENETIC DEPOSITS AND OCCURRENCES

Epigenetic deposits and occurrences described below are characterized by arsenic, copper, and gold; generally subordinate but locally dominant are silver, antimony, lead, zinc, tin, and bismuth.

Mineralized areas in southwestern half of area

Extensive mineralized areas are located near Partin and Canyon Creeks in the southern part of the mapped area (fig. 1). The mineralized area in Partin Creek is probably the one discovered by Albert Partin in 1917 and formerly covered by the Combination and Caribou claims (F. L. Thurmond, unpub. data, 1918). The mineralized area on Canyon Creek includes the Ready Cash prospect (Capps, 1919, p. 228–229; Ross, 1933, p. 318–320) and extends for at least a mile north of it.

Both mineralized areas are west of a major fault that is subparallel to and about 1½ miles to 4 miles west of the Upper Chulitna fault (fig. 1); they are in a unit of interlayered basalt and limestone which is faulted against red beds, argillite, and limestone to the east.

Partin Creek occurrence

Sulfides in the Partin Creek area (fig. 3) occur in a zone at least 3,000 feet long and as much as 1,000 feet wide, elongated parallel to the local structural grain. Rocks within the area contain visible pyrite, arsenopyrite, pyrrhotite, and chalcopyrite. The calcareous rocks of the area are stained with limonite; locally, only a limonite gossan remains. Sulfides in the basaltic units are generally fresh and occur as disseminations and veinlets and locally, in vesicules in amygdaloidal basalt. Analyses of random composite samples of sulfide-bearing rock (samples A–G, I, J) and of a grab sample from a quartz-arsenopyrite vein (sample H) are given in table 2. The samples contain 20–7,000 ppm (0.7 percent) copper, and most contain barely detectable to abundant silver, gold, and arsenic. Analysis of sample K (table 2) is from copper-bearing rocks exposed south of Partin Creek approximately at long. 150°00" W. (fig. 1).

Canyon Creek occurrence and Ready Cash prospect

Mineralized rocks in the Canyon Creek area occur in a unit of basalt and interlayered limestone with minor amounts of hornfelsed argillite (fig. 4). The area containing sulfides is more than a mile long and is elongated subparallel to a north-trending fault. A second fault is inferred in the valley of Canyon Creek. The mineralized bodies are veins of quartz, arsenopyrite, and other sulfides, and sulfides are disseminated in basalt, limestone, and hornfels. Occurrences of mineralized rock were sampled in three parts of the area (fig. 4). Analyses of these samples (samples 1–8, table 3) suggest that copper, arsenic, tin, lead, zinc, silver, and minor amounts of gold are characteristic of the mineralized area. With the exception of tin, these metals or their minerals were reported by Capps (1919) and Ross (1933) at the Ready Cash prospect at the south end of the mineralized area. Tin was detected in all but one sample and exceeds 0.1 percent in one quartz-arsenopyrite-galena vein.

The Ready Cash prospect was sampled and described by Capps (1919), Ross (1933), and F. L. Thurmond (unpub. data, 1918). Thurmond reported a maximum silver assay of 183 oz per ton (ounces per ton) on selected galena from the prospect and a range of 5–120 oz per ton of silver on other sulfide-rich samples. A maximum assay of about 15 oz per ton of silver was determined in samples collected during our brief investigation. Ross (1933, p. 318–320) believed that the numerous vein exposures in the vicinity of the Ready Cash prospect were the result of the faulting of a single lode, but helicopter reconnaissance suggests that there are several distinct veins.

Sulfide mineral occurrences (sample localities 9–12) are also found in precipitous terrain about 2½ miles northeast of the Ready Cash prospect (fig. 4).

A possible extension of the mineralized area exposed near Canyon Creek is indicated by anomalous concentrations of copper or zinc in stream-sediment samples from nearby drainages (fig. 4).

Ohio Creek tin-bearing greisen

A greisen-type tin occurrence was found 3½ miles northwest of the Canyon Creek area on upper Ohio Creek. The occurrence consists of muscovite and tourmaline-bearing greisen and quartz-arsenopyrite veins in a tourmaline-bearing granite stock. The stock is about a mile long and one half of a mile across (fig. 1).

One traverse was made across the part of the stock east of the Ohio Creek Glacier, and greisen was found adjacent to a biotite-rich inclusion. This inclusion is at least 150 feet long and is elongated approximately parallel to a southwesterly trending gulch. A zone of tourmaline greisen as much as 10 feet thick on the south and southeast sides of the inclusion contains as much as 300 ppm tin (lab. No. AGJ976, table 4). The tourmaline greisen grades into muscovite-bearing greisen that is as much as 3 feet thick and contains more than 1,000 ppm tin (lab. No. AGJ975, table 4). Another sample of greisen collected southeast of the gulch also contained more than 1,000 ppm tin (lab. No. AGJ977). The upper 3–10 feet of the granite near its contact with country rock in the northeastern part of the stock locally contains pegmatitic quartz-arsenopyrite veins, and they parallel the 50° NE. dip of the contact. A grab sample of one of these veins contained more than 1,000 ppm tin (lab. No. AGJ978).

Table 2.—*Analyses of samples from the Partin Creek area*

[Analysts: Joe Curry and R. L. Miller. Gold analyses by atomic absorption. Other analyses are semiquantitative spectrographic and are reported in the series 0.1, 0.15, 0.2, 0.3, 0.5, 0.7, 1.0, 1.5, and so on, or by the following symbols: N, not detected; L, detected but below limit of determination. Results are given in parts per million except Fe and Ti, which are given in percent. Sample localities, except K (south of Partin Creek), shown in figure 3]

Sample Locality	Lab. No.	Field No.	Ag	As	Au	Cu	Mo	Pb	Sb	Zn	Fe	Ti
A	ACL503	68ACK344A	0.7	1,500	0.1	200	L	L	N	L	10	0.5
B	504	344B	N	700	.5	1,500	15	L	N	L	20	.7
C	505	344C	N	N	N	20	L	20	N	N	3	.5
D	506	344D	N	N	.1	300	5	L	N	L	15	>1
E	507	344E	L	N	.9	700	L	L	N	N	10	>1
F	508	344F	N	3,000	.7	700	7	L	N	L	15	>1
G	509	344G	300	N	.1	20	L	N	N	L	7	>1
H	510	344H	1	>10,000	63	7,000	30	100	7,000	300	20	.015
I	511	344I	.5	500	.2	700	7	L	N	L	15	>1
J	512	344J	.5	L	.02	700	10	L	N	200	20	>1
K	AGJ849	68ACK308	N	N	.2	1,500	L	L	N	L	20	>1
Limits of determination----			0.5	200	0.02	5	10	10	100	200	0.05	0.001

Samples of greisen or vein material mentioned above and altered country rocks also contain measurable amounts of silver, gold, copper, lead, zinc, and tungsten (table 4).

Stream sediment from the gulch contains about 150 ppm tin, 200 ppm arsenic, 300 ppm copper, 7 ppm beryllium, 5 ppm silver, 700 ppm zinc, and a trace of tungsten.

Mineralized areas in northeastern half of area

Mineral deposits and occurrences are relatively numerous in the northeastern part of the area (fig. 1), sometimes called the Golden Zone-Silver King mineraized area. Disseminated mineral occurrences were identified in 1968 near Costello Creek 2½ miles east-southeast of the Silver King prospect and in upper Camp Creek 3 miles northeast of the Silver King (fig. 1). The occurrences are in porphyry and, although low grade, seem large enough to warrant further study and sampling. The dominant elements in the Costello Creek deposit are copper, arsenic, and gold; elements present in smaller amounts are silver, bismuth, and tin. Another disseminated mineral occurrence is near Lookout Mountain (fig. 1), where the mineralized rocks contain silver, lead, zinc, and traces of arsenic, gold, and tin. Apparently, neither the Lookout Mountain nor the Costello Creek occurrences have been prospected. An occurrence south of Long Creek has been partly exposed in trenches but not described previously. It is characterized by arsenic, copper, bismuth, tin, and gold.

Costello Creek occurrence

A fine-grained locally garnetiferous diorite porphyry contains sulfides both on fracture surfaces and disseminated over an area about one-fourth of a mile wide by three-fourths of a mile long (fig. 5). The porphyry is part of the stock that underlies the low hills northeast of Costello Creek (fig. 1). Porphyry near samples 1A and 2A (fig. 5, table 5) is estimated to contain from 1-3 percent sulfides; arsenopyrite, pyrite, pyrrhotite, and chalcopyrite are visible megascopically. At sample locality 3A, the rock is brecciated fine-grained porphyry with minor hornfels. At sample localities 3A, 4A, and 5A sulfides are estimated to constitute from ½-2 percent of the rock. A sample (6A) of a granite porphyry dike that cuts diorite porphyry did not contain metals in anomalous concentration.

Camp Creek occurrences

Mineralized rock is exposed over approximately one-fourth of a mile in upper Camp Creek in sec. 5 and near the center of sec. 9, T. 19 S., R. 10 W. (fig. 5). Exposures are poor, but the mineralized rock is altered fine-grained porphyry which protrudes through coal-bearing Tertiary rocks (fig. 5). In sec. 9, an intrusive body is in contact with pre-Tertiary rocks to the east.

The highest metal concentration in samples from Camp Creek (sample 6B, table 5) was 0.6 ppm gold, 500 ppm copper, and 1,000 ppm zinc. Other samples contained appreciably less metal, but mineralization in all samples except sample 1B was indicated by the presence of zinc, bismuth, and antimony.

The occurrences in Camp Creek and mineralized rock north of Costello Creek suggest that mineral deposits may be buried beneath the extensive cover of Tertiary and Quaternary rocks at the north end of the Golden Zone-Silver King mineralized area.

Lookout Mountain occurrence

The mineral occurrence at Lookout Mountain is in a small, locally brecciated, and poorly exposed body of

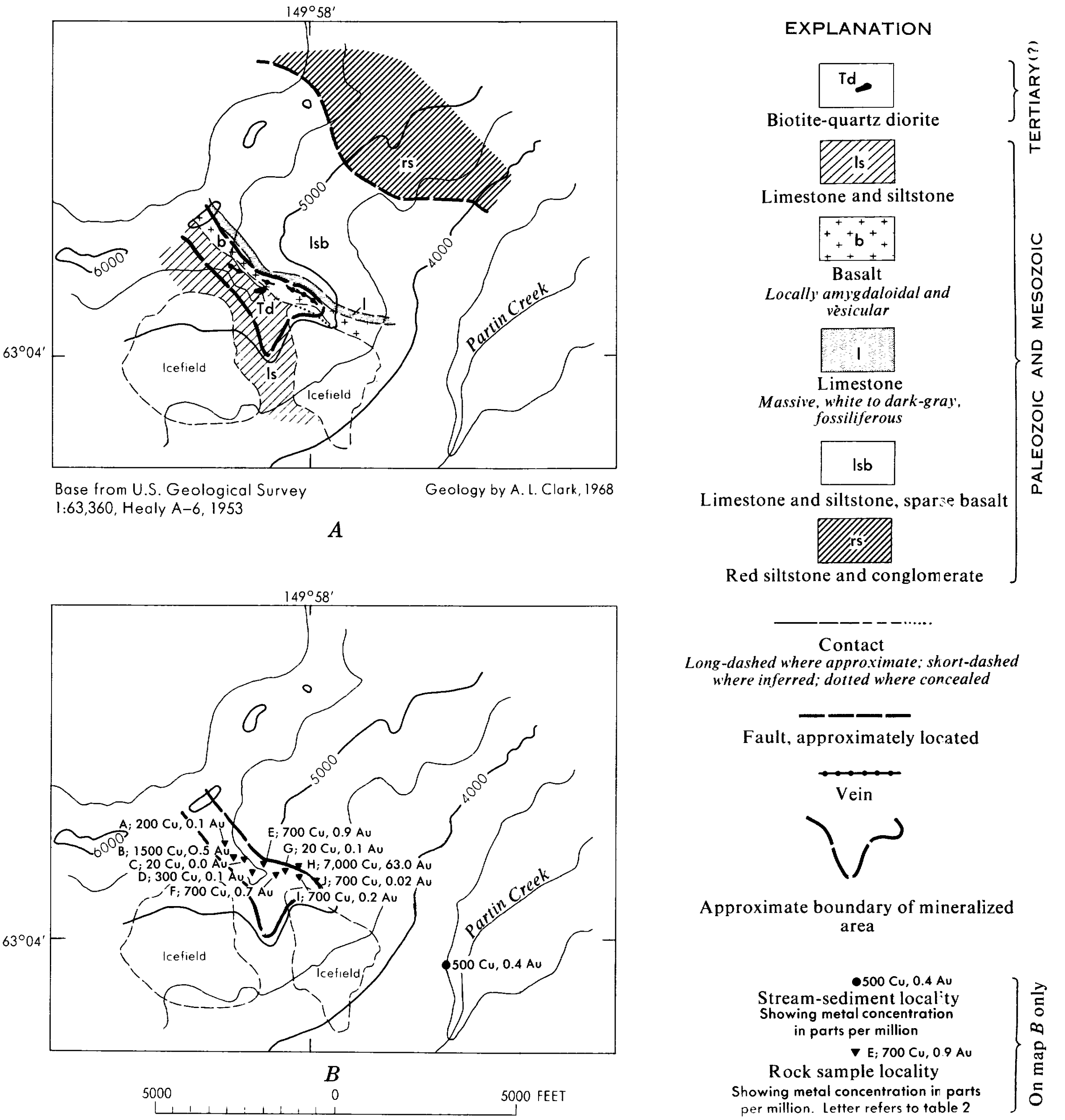

Figure 3.—Maps of the Partin Creek area. *A*, Reconnaissance geologic map. *B*, Sample localities and concentration of copper and gold.

quartz porphyry and felsite emplaced in strongly sheared dark-gray to black argillite and quartzite. Scattered exposures (fig. 6) suggest that the intrusion is roughly circular with a diameter of 1,200 feet.

The intrusive rock is light colored and varies from uniformly fine-grained felsite to quartz porphyry with quartz phenocrysts 2–3 mm (millimeters) in size. Four samples of mineralized intrusive rock collected along the main gulch (samples 1–4, table 5) contain anomalous amounts of zinc, lead, and silver, and trace amounts of tin. A 10-foot-wide dike of quartz porphyry exposed one half of a mile downstream (sample 5) contains traces of the same suite of elements. Shear-zone material in the main intrusive (samples 6 and 7) is also characterized by zinc, lead, silver, and tin, as is

Table 3.—*Analyses of samples from the Canyon Creek area*

[Analysts: Joe Curry and R. L. Miller. Analyses, unless noted, are semiquantitative spectrographic and are reported in the series 0.1, 0.15, 0.2, 0.3, 0.5, 0.7, 1.0, 1.5, and so on, or by the following symbols: N, not detected; L, detected but below limit of determination. Results given in parts per million except for Fe, which is given in percent]

Sample No.	Lab. No.	Field No.	Ag	As	Au[1]	Cd	Cu	Mo	Pb	Sb	Sn	Zn	Fe
1	AGJ979	S7—9	150	>10,000	0.3	300	[1]7,800	10	1,000	100	300	7,000	15
2	ACJ869	4	500	>10,000	.4	500	3,000	7	>20,000	700	>1,000	10,000	15
3	865	1	7	N	.4	N	5,000	15	N	N	L	L	10
	866	1B	.7	N	.02	N	700	7	N	N	L	N	7
4	867	2	3	700	.06	N	150	7	300	N	L	L	5
5	868	3	3	500	.04	N	300	7	15	N	10	200	10
6	590	M—812	3	L	.02	N	300	L	70	N	700	300	7
7	591	M—814	10	>10,000	.3	N	1,000	10	100	500	150	L	15
	592	814B	3	200	.02	N	700	5	10	N	150	L	10
8	593	815	N	N	.04	N	100	N	L	N	N	N	2
9	881	S6—43	N	N	.1	N	[1]150	5	L	N	N	200	20
10	883	45	2	L	.9	N	[1]4,000	15	L	N	N	L	15
11	884	46	N	N	.1	N	[1]500	L	L	N	N	N	7
12	897	46B	3	700	.8	N	300	5	300	3,000	N	200	10
Limits of determination--------			0.5	200	0.02	20	5	10	10	100	10	200	0.05

[1]Atomic absorption.

Sample No.	*Lab. No.*	*Sample type*	*Description*
1	AGJ979	2-foot chip	Chalcopyrite-arsenopyrite vein in Canyon Creek approximately 100 feet from portal of lower Ready Cash adit.
2	AGJ869	Grab	Quartz-arsenopyrite vein material.
3	AGJ865	Chip	Copper-stained gossan material.
	866	Grab	Iron-stained hornfels.
4	AGJ867	Chip	Iron-stained argillite and quartz-pyrite vein material; inferred fault zone.
5	AGJ868	Grab	Iron-stained basalt unit approximately 30 feet wide.
6	AGJ590	50-foot chip	Reddish-brown altered basalt. Dark-green amygdules.
7	AGJ591	Grab	1½- to 2-foot quartz vein, approximately 50 percent sulfides, mainly arsenopyrite with minor chalcopyrite and tetrahedrite(?).
	592	Grab	Same as AGJ591.
8	AGJ593	Grab	Dark-green to black amygdaloidal basalt.
9	AGJ881	Grab	Contact zone between basalt and limestone.
10	AGJ883	Grab	1- to 1½-foot vein or pod of quartz and sulfides. Near contact of diorite porphyry and hornfelsed argillite.
11	AGJ884	Grab	Sulfide-bearing hornfels. Less than 2 percent pyrrhotite, chalcopyrite, and sphalerite.
12	AGJ897	Surficial	Colluvium below AGJ884.

a limonite-stained sericitic breccia (sample 8). Similar breccia, which contains fragments of both intrusive and country rock, is exposed west of the gully. Silver is also present, but near the limit of detection, in the adjacent clastic country rocks (samples 9, 10, and 11).

Long Creek prospect

Shallow trenches and prospect pits south of Long Creek (fig. 1) expose a weakly mineralized area approximately 300 by 600 feet (fig. 7). Minor amounts of galena, sphalerite, pyrite, and chalcopyrite occur in massive quartz-arsenopyrite veins and as disseminations in the country rock. Sampling of the area (table 5) indicates anomalous concentrations of gold, silver, arsenic, and copper, and minor amounts of molybdenum, bismuth, lead, antimony, tin, and zinc. The metal suite of the occurrence is typical of the area, but bismuth, antimony, and tin are present in larger concentrations and in more samples than in most nearby deposits.

The country rocks of the mineralized area are dense dark-gray hornfelsed conglomerates, breccias, and shales that are cut by a small plug and dikes of quartz porphyry. The metamorphosed country rock contains 1-2 percent disseminated sulfides, primarily pyrite and arsenopyrite with minor amounts of chalcopyrite. The intrusives are stained with limonite and locally contain abundant pyrite and arsenopyrite.

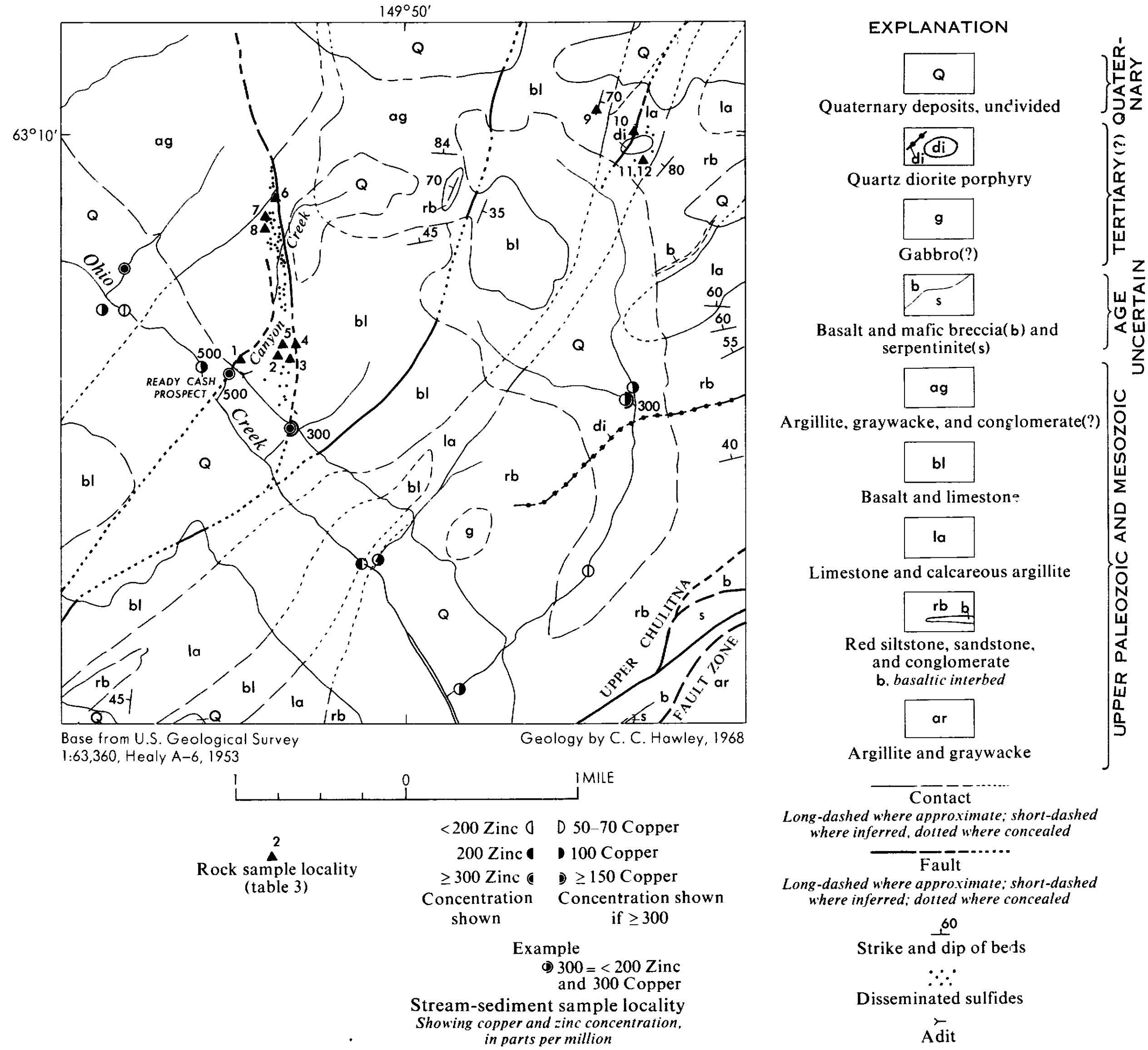

Figure 4.—Geologic map of the Canyon Creek area showing sample locations.

Most exposures in the area are in pits and trenches, and some of these are caved. Massive arsenopyrite vein material was found in place in only two pits (samples A and N, table 5), although massive vein material was also found on four other dumps. This fact and the uniformity of gold content in five of the six samples suggests that vein material may have been moved to some of the pits from one or another of the vein outcrops. Although the significance of the prospect cannot, therefore, be assessed without further sampling, the country rocks are sulfidized. Vein materials contain gold and appreciable amounts of silver, bismuth, and tin, and sediment in the stream draining the prospect area shows 7 ppm Ag and 70 ppm Pb (Hawley and Clark, 1968, sample 44, table 3).

GEOCHEMICAL ANOMALIES IN STREAM SEDIMENTS

One hundred and sixty five stream-sediment samples, including some duplicates, were collected in the area in 1967 and 1968. The samples were collected, where possible, from active streams, and the -80 mesh fraction was analyzed for gold by an atomic-absorption method and for 30 other elements by a semiquantitative-spectrographic method.

Of those elements, silver, gold, copper, lead, zinc, and arsenic occur in enough samples and had sufficient range in concentration to be generally useful in determining anomalies. Medians, shown below, and limits of anomalous concentrations were estimated from

Table 4.--*Analyses of samples from the Ohio Creek occurrence*

[Analysts: Joe Curry, R. L. Miller, R. Tripp, W. R. Vaughn, and E. E. Martinez. Analyses, unless noted, are semiquantitative spectrographic and are reported in the series 0.1, 0.15, 0.2, 0.3, 0.5, 0.7, 1.0, 1.5, and so on, or by the following symbols: N, not detected; L, detected but below limit of determination; H, interference. Results are given in parts per million]

Lab. No.	Field No.	Ag	As	Au[1]	B	Be	Bi	Cd	Cu	Mo	Pb	Sb	Sn	W	Zn
AGJ973	S7—6A	3	L	0.04	>2,000	5	L	N	10	N	30	N	15	70	700
974	6B	5	N	.04	>2,000	5	10	150	150	L	50	L	200	L	2,000
975	6D	30	3,000	.04	H >50	3	30	50	150	N	200	L	>1,000	150	L
976	6F	7	L	.04	>2,000	5	20	N	1,500	L	20	N	300	N	700
977	6G	70	300	.02	30	15	N	N	150	N	30	N	>1,000	50	L
978	6I	20	>10,000	.04	30	3	20	N	1,000	L	300	150	>1,000	30	L
Limits of determination--		0.5	200	0.02	10	1	10	20	5	5	10	100	10	50	200

[1]Atomic absorption.

Lab. No.	*Description*
AGJ973	Quartz-tourmaline veined granite (in float).
974	Mica schist (in float, possibly from inclusion).
975	Muscovite-quartz-arsenopyrite greisen adjacent to tourmaline greisen AGJ976.
AGJ976	Tourmaline greisen.
977	Quartz-muscovite greisen exposed.
978	Quartz-arsenopyrite vein parallel to contact of granite and country rock.

cumulative frequency distribution diagrams. These are given with geochemical maps in the supplementary open-file report (Hawley and Clark, 1969).

Element	*Median*	*Lower limit of anomalous concentrations* (*parts per million*)
Ag------	<0.5	0.5
As------	<200	Detected (limit of determination is 200 ppm)
Au------	<.02	.02
Cu------	70	150
Pb------	15	30
Zn------	<200	200

Because of the high limits of detectability of silver, arsenic, gold, and zinc compared to their relative scarcity in the area, medians could not be calculated directly. However, projections on the cumulative frequency diagrams show that the median concentrations are probably less than one-half of the limit of anomalous concentration. Antimony and tin are found in a very few samples; these elements are likewise scarce compared to their analytical detectability and are considered anomalous if seen spectrographically.

Elements such as copper and gold (listed in the preceding section) are found locally in anomalous concentrations in stream sediments not only below known occurrences but also in drainages in which metallized rocks have not yet been found. The analyses presented graphically in the companion open-file report (Hawley and Clark, 1969) are summarized in figure 8. The map shows which elements are present in anomalous concentrations in stream-sediment samples of the area.

ANOMALIES RELATED TO KNOWN DEPOSITS OR OCCURRENCES

Anomalies related to known occurrences are found in several areas, such as near Lookout Mountain, the Long Creek prospect, Golden Zone, Canyon Creek, upper Partin Creek, and the Ohio Creek tin-bearing greisen. Maximum metal concentrations in stream sediments from these areas are shown in table 6. In the upper Partin Creek area, anomalous concentrations of one or more metals persist at least 2 miles below the occurrence; in Bryn Mawr Creek, below the Golden Zone, several elements persist for more than 2½ miles, and arsenic remains at or above 3,000 ppm to the mouth of the creek. Mineralization in and near Canyon Creek is marked mainly by high metal concentrations in tributary valleys but not in the broad alluviated valley of Ohio Creek. In the upper Ohio Creek area, maximum concentrations of tin and other elements and visible greisen (northernmost sample) are found in the gulch. However, the presence of copper, antimony, zinc, and a trace of tin and tungsten in a tributary to Ohio Creek below the occurrence suggests that related mineralization extends east of the granite stock into the next drainage basin.

ANOMALIES OF UNKNOWN ORIGIN

Anomalies of unknown origin are grouped into two types: (1) Those with abundant metals, and (2) those with metal concentrations at or near the limit of anomalous values. The concentrations in the first type are similar to those found below known metal occurrences and probably indicate nearby mineralized rocks. The anomalies in Coal Creek and Long Creek (fig. 8) are of this type; both show gold equal to or greater than 0.1 ppm, while the Coal Creek sample has 3 ppm Ag and 700 ppm Zn, and the richest Long Creek sample

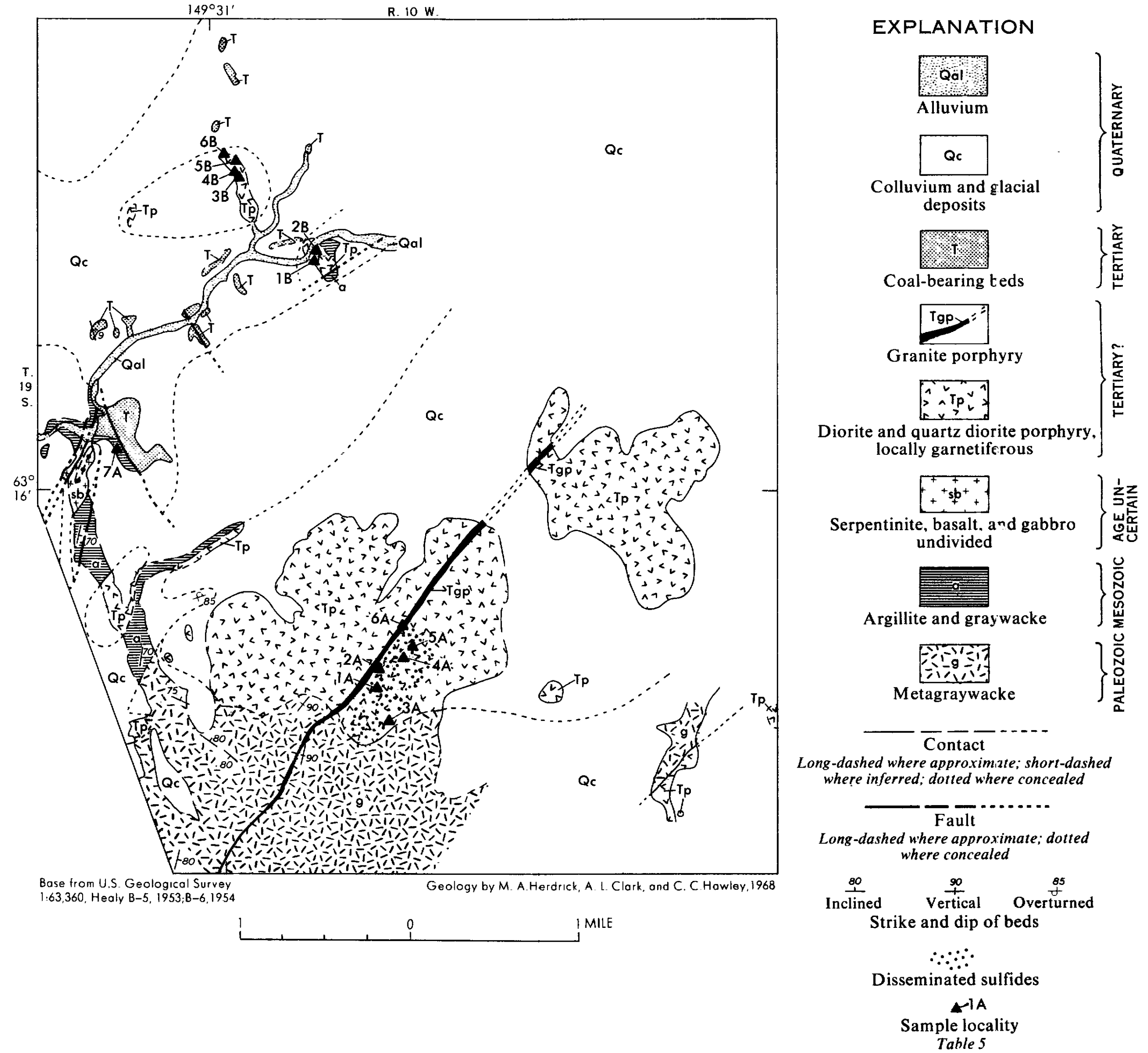

Figure 5.—Geologic map of the northeastern part of the Golden Zone-Silver King mineralized area showing sample locations.

has 500 ppm As and 150 ppm Cu. A high concentration of chromium and nickel at Coal Creek (fig. 2) suggests that metallized rocks may occur in or near serpentinite.

Anomalies of the second type are represented mainly by samples from Shotgun and McCallie Creeks and from the upper Costello Creek area (fig. 8). Shotgun and McCallie Creeks head in the interlayered basalt-limestone terrane (fig. 1), which is the host rock of deposits at Partin and Canyon Creeks; both streams have multiple-element anomalies. In contrast, only one of four samples from Little Shotgun Creek, which heads in red beds, has an anomalous amount of metal. The metals found in Shotgun and McCallie Creeks are gold, copper, and, less commonly, zinc, arsenic, and antimony. These metals also characterize the occurrences at Partin and Canyon Creeks, and the data suggest that hitherto undiscovered mineral occurrences may be located in the limestone-basalt terrane between these two areas. The metal concentrations of the samples from Shotgun and McCallie Creeks are near the limit of anomalous concentrations; that is, gold ranges only from 0.02-0.06 ppm, copper is 150 ppm, arsenic and antimony are barely detected, and zinc is 200 ppm. Although these relatively low concentrations may indicate only weak metallization, most of the sample sites are more than a mile from the most likely host for lode occurrences—the limestone and basalt—and could, therefore, indicate normal downstream dilution of an anomaly.

Table 5.—*Analyses of samples from occurrences in the Golden Zone-Silver King mineralized area*

[Analysts: Joe Curry, E. E. Martinez, and R. L. Miller. Gold analyses by atomic absorption. Other analyses are semiquantitative spectrographic and are reported in the series 0.1, 0.15, 0.2, 0.3, 0.5, 0.7, 1.0, 1.5, and so on, or by the following symbols: N, not detected; L, detected but below limit of determination. Results are given in parts per million except Fe and Ti, which are given in percent. Samples 1—5 (from Lookout Mountain) taken from felsite and quartz porphyry, samples 6 and 7 from a shear zone, sample 8 from breccia, and samples 9—11 from black argillite and quartzite]

Sample No.	Lab. No.	Field No.	Ag	As	Au	Bi	Cd	Cu	Mo	Pb	Sb	Sn	Zn	Fe	Ti
						Costello Creek (sample localities shown in fig. 5)									
1A	AGJ645	HB6—M53	0.7	>10,000	0.3	150	N	500	L	10	N	15	N	15	0.7
2A	646	M54	.5	200	.4	30	N	1,000	N	L	N	L	N	20	1
3A	956	MH—835	L	N	N	N	N	70	N	L	N	15	N	10	.5
4A	957	836	.7	300	.3	30	N	150	L	N	N	N	L	7	.3
5A	958	837	3	400	N	30	N	700	L	N	N	50	L	10	.7
6A	959	837B	L	L	N	N	N	10	N	20	N	L	L	3	.15
7A	641	HB6—M44	7	N	.2	N	N	500	N	L	150	N	N	5	.7
						Camp Creek (sample localities shown in fig. 5)									
1B	AGJ630	68ACK140	L	N	N	N	N	70	N	10	N	N	N	5	0.2
2B	631	141	L	N	N	L	N	70	L	15	150	N	L	10	.5
3B	632	147	L	L	.02	L	N	10	N	100	N	N	L	10	.5
4B	633	148	L	N	N	L	N	100	L	150	L	N	700	7	.5
5B	634	149	.5	L	N	L	N	10	7	50	L	N	500	7	.5
6B	635	150	.7	N	.6	L	30	500	20	50	150	N	1,000	15	1
						Lookout Mountain (sample localities shown in fig. 6)									
1	AGJ935	68ACs858D	10	N	N	N	N	20	N	300	N	10	500	3	0.05
2	936	858E	15	L	N	N	N	10	N	150	L	30	500	2	.05
3	937	858F	3	L	N	N	N	15	N	150	N	15	500	3	.05
4	939	866	30	L	.04	N	N	150	L	700	L	50	L	7	.5
5	941	868B	.7	N	N	N	N	20	L	1,500	300	50	700	3	.2
6	933	858B	3	N	N	N	N	30	N	150	N	15	500	5	.5
7	934	858C	3	N	N	N	N	100	L	70	N	10	200	7	.5
8	938	861	15	N	N	N	N	20	N	500	L	30	700	3	.15
9	932	857	1	N	N	N	N	20	L	30	N	10	N	3	.7
10	697	862	1	N	N	N	N	20	L	30	N	L	N	3	.5
11	940	867	.5	N	N	N	N	20	N	L	N	N	L	3	.3
						Long Creek prospect (sample localities shown in fig. 7)									
A	AGJ809	68ACK230A	500	>10,000	2.8	300	500	3,000	7	3,000	3,000	100	>10,000	20	0.01
B	810	B	1	L	.2	15	N	500	L	20	N	N	L	7	.3
C	811	C	200	>10,000	3.2	500	70	1,000	7	1,500	1,500	N	3,000	20	.03
D	812	D	2	1,500	.2	L	N	300	L	30	N	N	N	7	.2
E	813	E	1	N	.04	N	N	200	L	15	N	N	L	5	.3
F	814	F	2	N	.1	N	N	200	L	15	N	N	N	7	.5
G	815	G	.7	300	.06	N	N	200	L	10	N	N	N	7	.5
H	816	H	100	>10,000	3.1	150	N	3,000	7	1,000	1,500	10	300	>20	.02
I	817	I	.7	300	.06	L	N	300	L	15	N	N	L	7	.5
J	818	J	1.5	200	.06	L	N	300	5	20	N	L	L	7	.5
K	819	K	5	300	.3	15	N	500	L	50	100	L	L	7	.3
L	820	L	70	>10,000	3.6	150	N	700	7	300	1,000	L	300	15	.03
M	821	M	L	L	.04	N	N	150	L	N	N	N	N	1.5	.15
N	822	N	5	>10,000	11	1,000	N	700	7	50	500	N	N	10	.07
O	823	O	L	L	.04	N	N	200	L	10	L	L	L	7	.5
P	824	P	L	300	.06	N	N	150	L	10	N	L	N	3	.03
Q	825	Q	L	N	.04	N	N	150	L	L	N	L	L	7	.5
R	826	R	7	3,000	.2	10	30	700	L	200	L	100	700	7	.3
S	827	S	700	>10,000	3.2	150	500	3,000	7	3,000	2,000	700	>10,000	>20	.015
T	828	T	1.5	500	.06	N	N	150	5	30	N	15	300	7	.5
X	829	232	70	1,500	1.9	300	N	1,500	7	100	N	15	200	20	.3
Limits of determination--------			0.5	200	0.02	10	20	5	5	10	100	10	200	0.05	0.001

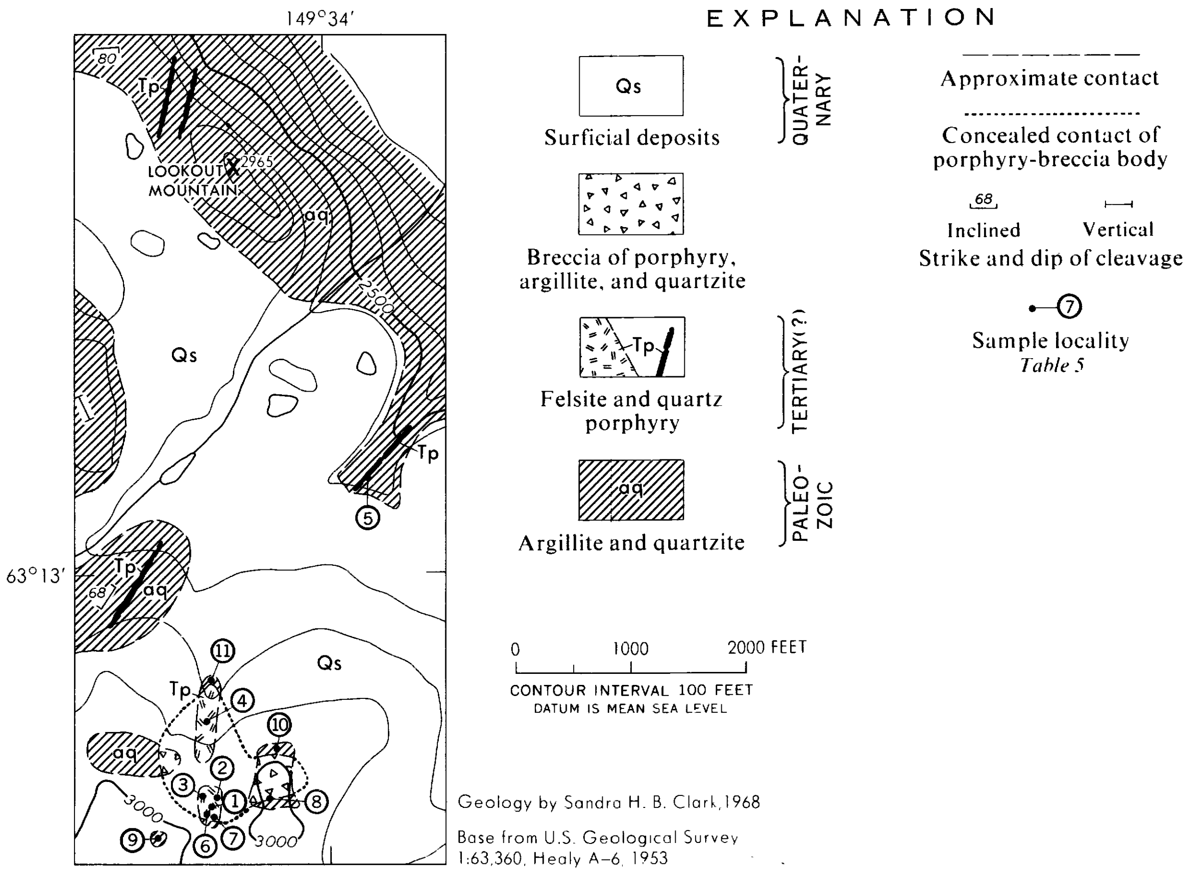

Figure 6.—Geologic map of the Lookout Mountain area.

Table 6.—*Maximum element concentrations, in parts per million, in stream-sediment samples below known deposits and occurrences*

[N, not detected; L, detected but below limit of determination]

	Lookout Mountain	Long Creek	Golden Zone	Canyon Creek	Partin Creek	Ohio Creek
Ag----	0.7	7	3	2	0.7	15
As----	200	N	5,000	200	700	200
Au----	N	N	.7	.02	.4	N
Cu----	150	70	300	500	500	300
Pb----	70	70	200	70	30	20
Sb----	N	N	N	L	L	L
Sn----	N	N	N	150	N	200
Zn----	500	L	200	500	200	700

Anomalous concentrations of zinc, arsenic, copper, and lead seem to characterize an area drained by upper Costello Creek. The same elements, especially zinc, are also found at several sites in lower Ohio, Copeland, and Long Creeks, and anomalous concentrations of zinc occur in upper Long and Copeland Creeks and in the area due west of the Golden Zone. The concentrations of the elements found in upper Costello Creek and the other sites mentioned are generally near the minimum for an anomaly; that is, in parts per million: Ag, 0.5–0.7; As, detected; Cu, 150; Pb, 30; and Zn, 200–300. The distribution of these low values suggests a broad mineralized zone centered around the Golden Zone-Silver King area.

SUMMARY AND RECOMMENDATIONS FOR PROSPECTING

Deposits or occurrences of copper-, gold-, silver-, and tin-bearing rocks are widely distributed throughout the area studied (fig. 1), and anomalous amounts of chromium or nickel are found at scattered localities along a linear zone of serpentinites (fig. 2). Although many of the known occurrences appear to be small or of low grade, the potential of the area appears good because of (1) the total number of occurrences, (2) the presence of favorable host rocks such as limestone, basalt, and tuff, (3) the diverse elements contained in the mineralized rocks, and (4) the existence of a known significant deposit at the Golden Zone.

An attractive site for exploration is the elongate Partin Creek-Canyon Creek mineralized area. The occurrences in the area are poorly known, but sulfidized rocks crop out over distances measured in thousands of feet at Partin Creek and Canyon Creek, and the host rocks are favorable for replacement deposits. The geochemical anomalies in Shotgun and

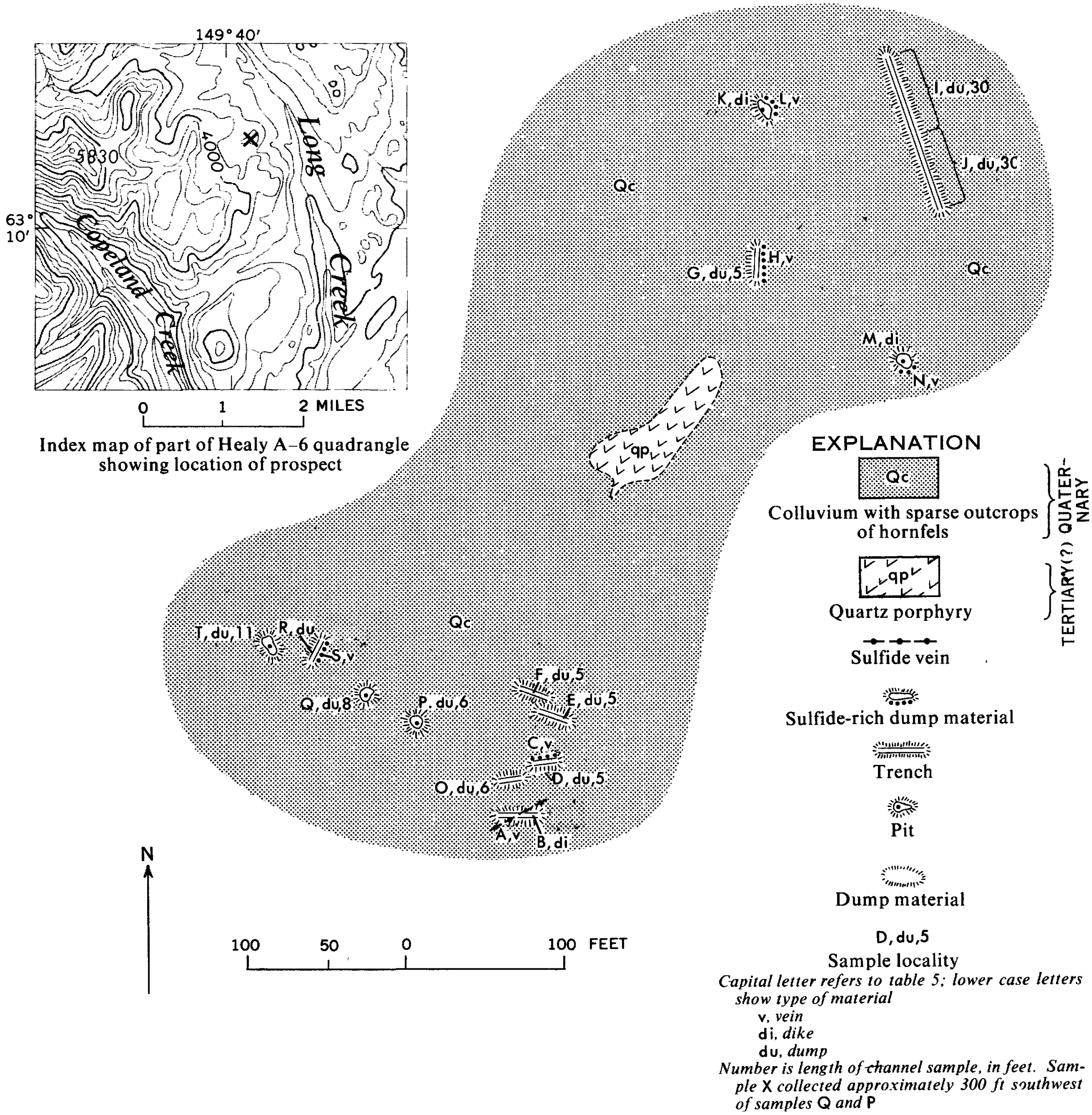

Figure 7.—Map of Long Creek prospect showing sample locations.

McCallie Creeks are probably caused by undiscovered mineralized rocks in the limestone and basalt in the headwater areas.

The granite with tin-bearing greisen in upper Ohio Creek has not been thoroughly investigated, and the amounts of tin at Canyon Creek and the Long Creek deposit are of interest.

The discovery of mineral occurrences in the northern part of the area near Costello and Camp Creeks suggests that sparse outcrops north of that area, such as the outcrops along the Bull River, should be examined.

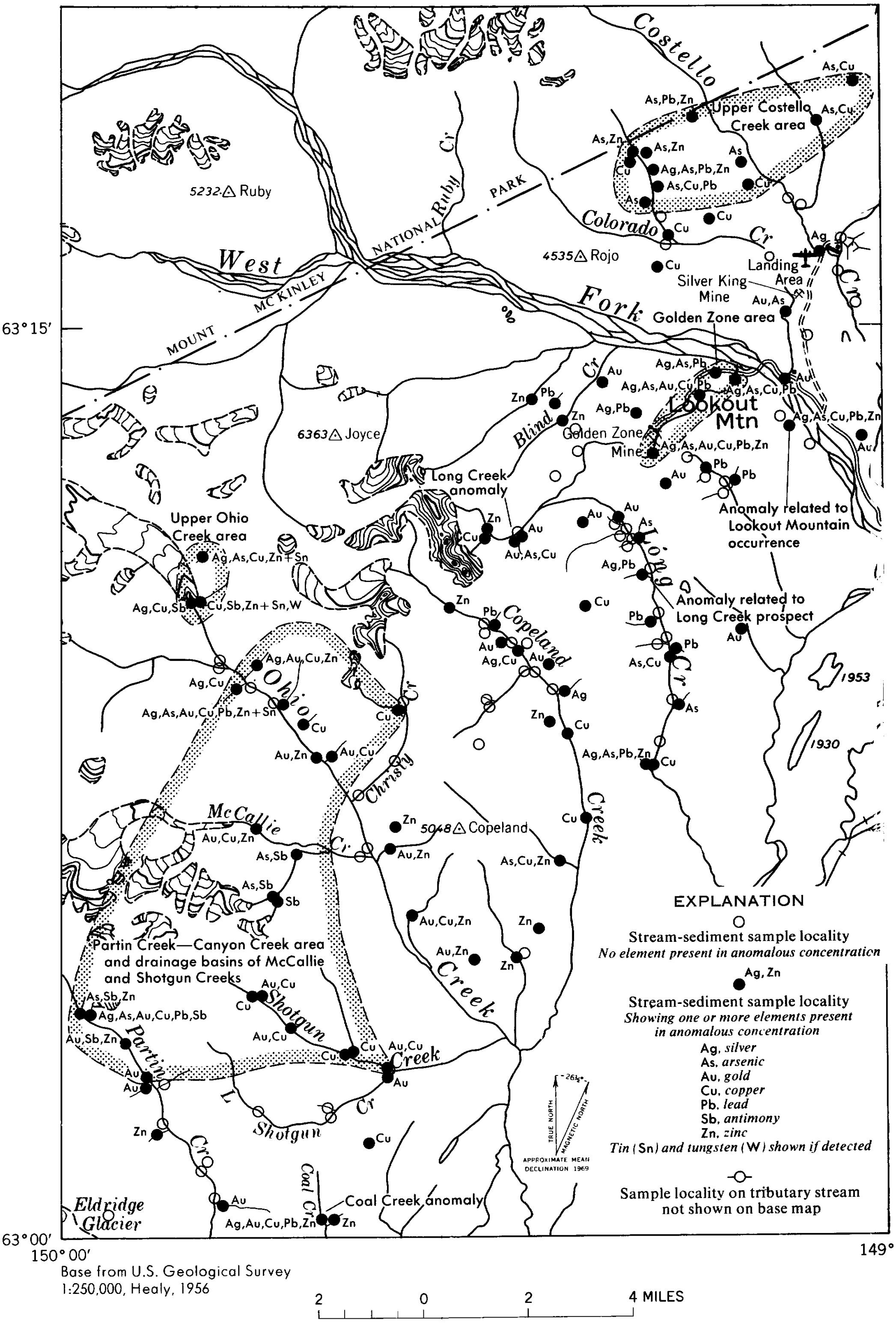

Figure 8.—Elements present in anomalous concentration in stream-sediment samples.

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