Lead, Zinc, and Silver Deposits at Bowser Creek McGrath A-2 Quadrangle Alaska

By Bruce L. Reed and Raymond L. Elliott

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Abstract

New occurrences of lead, zinc, and silver of potential economic significance were identified during a heavy metals investigation of the southern Alaska Range in 1967. The deposits, approximately 23 miles south of Farewell, are replacement bodies and fissure veins in limestone and fracture fillings in igneous breccia. Deposits in limestone show a close spatial relation to igneous breccia and granodiorite porphyry as well as to felsite dikes. Ore minerals are argentiferous galena and sphalerite. Deposits in breccia consist of pyrrhotite and sphalerite and may represent only part of a more extensively mineralized breccia mass. Although most of the deposits that crop out are sporadic and discontinuous, the number of occurrences with locally high silver content, their possible continuity beneath surficial deposits, and a favorable geologic environment suggest that the area has an economic potential for base and precious metals.

INTRODUCTION

New occurrences of argentiferous galena-sphalerite and sphalerite-pyrrhotite were identified in the summer of 1967 during a field geologic evaluation of the southern Alaska Range as part of the U.S. Geological Survey's Heavy Metals program. The deposits occur in limestone as replacement bodies and fissure veins adjacent to granodiorite, igneous breccia, and felsite dikes, and in the breccia as fracture fillings. The deposits appear to be sporadic and discontinuous but locally are quite rich.

The Bowser Creek area is approximately 23 miles south of Farewell, a Federal Aviation Agency station that maintains a 5,000-foot gravel runway (fig. 1). McGrath, about 62 air miles northwest of Farewell, is the nearest source of gasoline and supplies. No roads or trails lead to the area. The deposits can best be reached by helicopter. Small, properly equipped aircraft can land on gravel bars along the Post River; the deposits can then be reached by walking westward about 3 miles up Bowser Creek (fig. 2).

Bowser Creek basin is in rugged terrain, with relief of about 3,000 feet. The valley floor is mantled by surficial deposits. Talus covers the lower part of the surrounding slopes. There is virtually no vegetative cover in the basin; the nearest trees are along the Post River.

Little geologic information is available about this remote rugged sector of Alaska, the only previous work being that of Brooks (1911) who traversed the Alaska Range via the south fork of the Kuskokwim River in 1902. The present report is based on 2 days of examination and sampling. The area shown in figure 2 was mapped with the aid of a helicopter in about 5 hours, supplemented by aerial photointerpretation. The contacts and structural interpretations must be considered tentative; additional mapping of this and surrounding areas will be necessary before the geology and significance of the deposits can be fully understood.

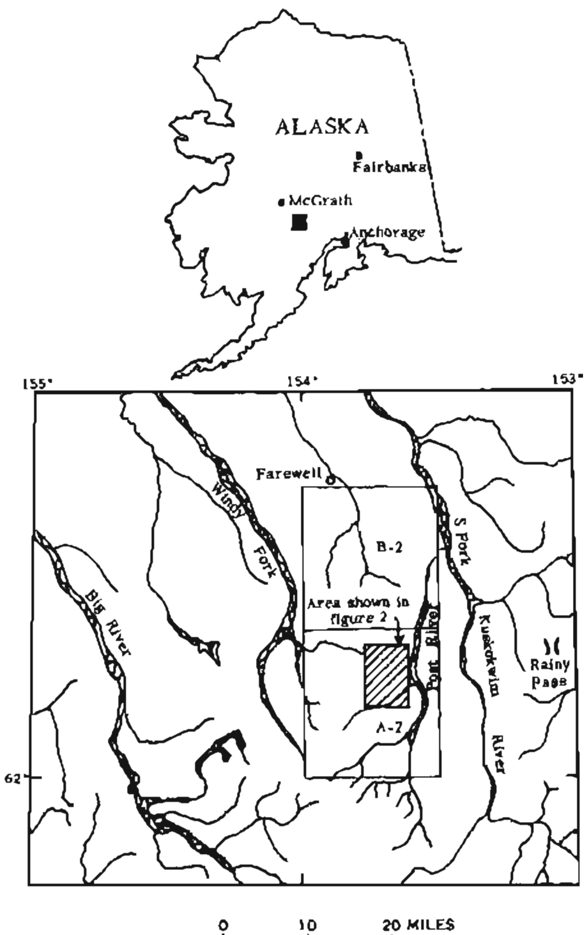

Figure 1.—Location of Bowser Creek area (fig. 2) and McGrath A-2 and B-2 quadrangles.

Base from U.S. Geological Survey, McGrath A-2, 1958

Geology by R. L. Elliott, C. P. Buckley and B. L. Reed, 1987

1 0 1 2 MILES

Contour Interval 100 Feet

Figure 2.—Generalized geology and sample locations at Bowser Creek, McGrath A-2 quadrangle.

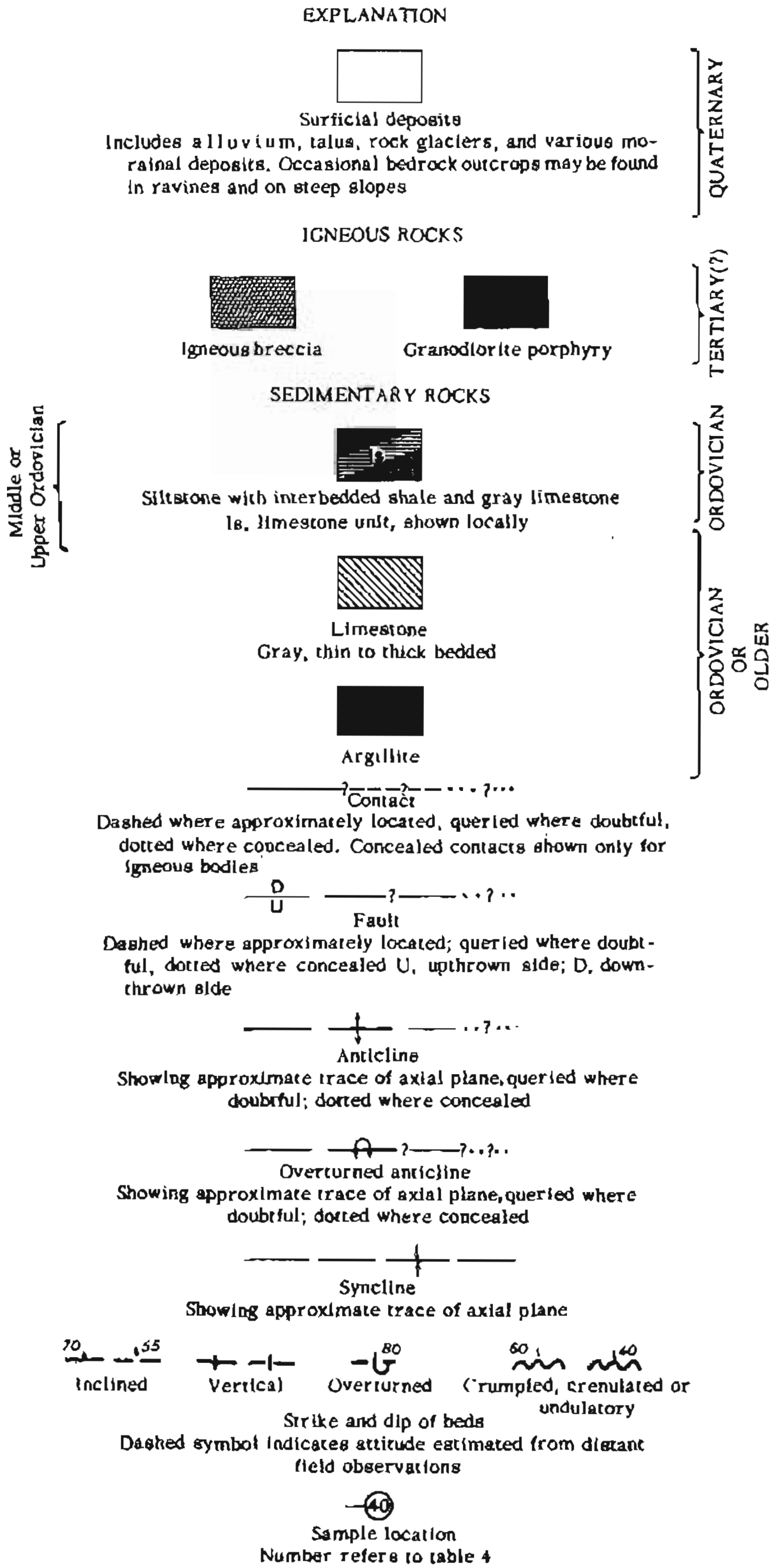

Figure 2.—Continued.

GEOLOGY

The Bowser Creek area is underlain by a folded sequence of limestone, siltstone and shale, and argillite cut by small intrusive bodies that locally have developed narrow contact aureoles. Mineral deposits are spatially related to the igneous rocks and occur both in limestone and in the igneous rocks themselves.

Bedded Rocks

Limestone, and siltstone with interbedded shale and limestone, are the predominant rocks in the Bowser Creek area. Dark-gray argillite appears to underlie the limestone in a northern tributary to Bowser Creek. Thus the apparent stratigraphic succession, from oldest to youngest, is argillite, limestone, and the predominantly siltstone unit. Rocks in this part of the Alaska Range are probably Paleozoic (Brooks, 1911). Graptolites, including species of Glyptograptus and Climacograptus, which indicate a Middle or Late Ordovician age (Michael Churkin, Jr., oral commun., 1968) were found in carbonaceous shale of the siltstone unit on the west fork of Jay Creek approximately half a mile west of the edge of the area shown in figure 2.

Intrusive Rocks

The sedimentary rocks of the Bowser Creek area are cut by two igneous breccia bodies, each about 1 mile across, and a small granodiorite porphyry body about 800 feet across. Many felsite and mafic dikes, too small to be shown on figure 2, are present throughout the mapped area. Some felsite dikes cut mafic dikes.

The southernmost igneous body forms a prominent chimneylike mass on the southwest side of Bowser Creek. It is a light-gray breccia that consists of angular to subangular rock fragments in a light-gray aphanitic matrix. The rock fragments range from microscopic particles, which form part of the matrix itself, to blocks a foot or more across. Silicated limestone, quartz-feldspar rock, and cognate inclusions make up a large part of these fragments, but many fragments are so extensively altered to quartz, epidote, leucoxene, sericite, chlorite, calcite, and opaque minerals that their original nature cannot be determined. Many fragments show corrosion of their borders. The matrix is a micro- to cryptocrystalline paste of plagioclase, quartz, and subordinate potassium feldspar and contains abundant fragments of quartz and plagioclase. The center of the breccia mass was not examined, but the rock glacier which heads near its center consists of boulders similar in composition to the outcrops examined near the edge.

The northernmost intrusive, also a breccia, underlies the basin at the headwaters of Bowser Creek. Its contacts with the enclosing rocks are largely concealed by surficial deposits. This intrusive was examined only along Bowser Creek, where it is a light-greenish-gray intrusive breccia similar in composition to the southern intrusive body. Near the southern contact, breccia fragments 0.25–2 inches in diameter make up 60 percent or more of the rock and are sharply angular, but away from the contact the fragments become more widely separated, the amount of matrix increases, and the fragments become more rounded. Specks and clots of a sulfide mineral (pyrrhotite?) are disseminated throughout the breccia, and veins filled with pyrrhotite and sphalerite locally fill fractures in the breccia.

A small body of granodiorite porphyry occurs on the north side of Bowser Creek (fig. 2). The contact of the porphyry with the enclosing limestone is covered, but the dimensions of the igneous body are approximately delineated by granodiorite porphyry rubble. The porphyry is yellowish gray with small (0.25–3 mm), partly corroded phenocrysts of plagioclase and subordinate subrounded quartz crystals in a microcrystalline aggregate of plagioclase, quartz, and potassium feldspar. Scattered prismatic crystals of hornblende are now altered to iron-rich chlorite and epidote. The plagioclase is usually turbid from incipient alteration.

Light-gray to white felsite dikes, from 1 to 50 feet thick, occur throughout the Bowser Creek basin. They vary in texture from an aphanitic equigranular aggregate of quartz, plagioclase, and potassium feldspar to porphyritic dikes with phenocrysts of plagioclase (partially altered to sericite, calcite or epidote) and rounded quartz crystals embedded in a very fine grained crystalline groundmass of feldspar and quartz. The felsite dikes intrude the bedded rocks, and along the upper reaches of Bowser Creek they cut igneous breccia.

Fine-grained dark-greenish-gray porphyritic mafic dike rocks locally are present. In thin section, altered phenocrysts of plagioclase and hornblende occur in a felted groundmass of altered plagioclase and femic alteration products. The plagioclase phenocrysts are extensively saussuritized, chiefly to albite and epidote. The original hornblende phenocrysts have retained their prismatic form but now are wholly altered to actinolite, epidote, chlorite, and opaque minerals, as are the primary groundmass mafic minerals. Irregular grains of potassium feldspar in the groundmass make up less than 5 percent of the rock. Originally these dike rocks were probably hornblende andesite.

Metamorphism

Rocks of the Bowser Creek area show little or no effects of regional metamorphism. However, within a hundred feet or so of the contact with intrusive bodies, limestone and pelitic country rock may be converted to hornfels. Contacts for the most part are poorly exposed because of extensive talus cover, but where field examination was possible, normally gray limestone is in many places bleached and recrystallized to a hard fine-grained silicated marble or calc-silicate hornfels. The pelitic rocks are baked and converted to a hard fine-grained hornfels. Such effects are evident adjacent to the northern intrusive breccia exposed in the headwaters of Bowser Creek.

The most conspicuous metamorphic effects, and those which appear to have the greatest potential economic significance, are skarn zones developed near felsite dikes and granodiorite porphyry. Ore minerals in the skarn are pyrrhotite and sphalerite (marmatite) with associated calc-silicate minerals, chiefly epidote and clinopyroxene. The skarn replaces silicated limestone. Generally within 10 feet of the sulfide-rich skarn bodies, the rock is altered to light-greenish-gray dense silicated marble composed of quartz, epidote, clinopyroxene, calcite, and chlorite.

Structure

The sedimentary strata have been deformed into folds which trend north-northeast and plunge to the south-southwest and north-northeast. The folds are locally overturned; axial planes are vertical or dip steeply to the east-southeast. Subsidiary asymmetric and disharmonic folds with wavelengths of a few inches to tens of feet were noted on the limbs of the larger folds. Faults, mapped from aerial photographs, are of two generations. The north-trending fault exposed south of Bowser Creek apparently accompanied the main period of folding. Cross faults of small apparent displacement (not shown in fig. 2) border the southern intrusive breccia.

The northeast-trending structural features are cut by intrusions of igneous breccia and associated felsite and subordinate mafic dikes. The southern breccia body shown near the center of figure 2 cuts the southwest end of an elongate locally overturned anticline. The northern breccia body cuts subparallel folds.

MINERAL DEPOSITS

The mineral deposits are of two main types: (1) galena-sphalerite or sphalerite-phrrhotite deposits in limestone and (2) narrow pyrrhotite-sphalerite fracture fillings in igneous breccia. The deposits in limestone are in two areas, one southwest and the second northeast of Bowser Creek. The deposits in igneous breccia are near the headwaters of Bowser Creek. The locations of all three areas are indicated in figure 2. All deposits are closely associated with intrusive igneous bodies.

Deposits in Limestone

The galena-sphalerite or sphalerite-pyrrhotite deposits in limestone consist of replacement bodies and fissure veins. Sphalerite (marmatite) and pyrrhotite are the ore minerals in the replacement bodies; argentiferous galena, with or without other sulfide min-

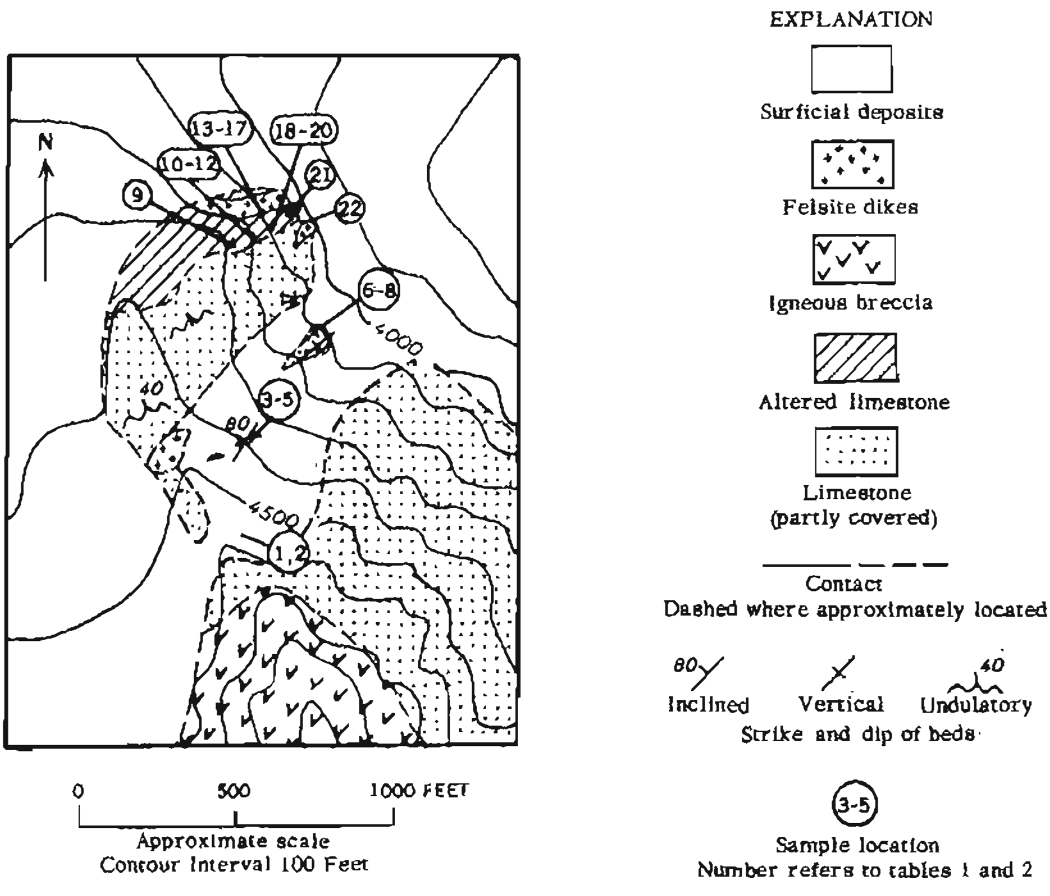

Figure 3.—Geology and location of samples on southwest side of Bowser Creek.

erals (chiefly marmatite), characterizes the fissure veins. Pyrite and minor chalcopyrite are locally present. The replacement bodies range from a few inches to 10 feet in width. They are generally tabular or podlike and replace silicated limestone. Individual podlike bodies may consist of as much as 85 percent combined sphalerite and pyrrhotite. The long axes of the pods are generally parallel to the bedding of the limestone. Many bodies were observed to pinch out within a few feet.

Area southwest of Bowser Creek.—Deposits of sphalerite-pyrrhotite and argentiferous galena are concentrated in an area on the southwest side of Bowser Creek (figs. 2, 3). Analyses for gold, silver, copper, lead, and zinc, and semiquantitative spectrographic analyses for the samples collected in this area are given in tables 1 and 2.

The largest replacement body examined (table 1, samples 3-5) has a vertical dip and an apparent width of 10 feet. Chip samples across this body indicate as much as 14.7 percent zinc and 6.1 ounces of silver per ton. Only the south side of the body is exposed; the contact is parallel to the limestone beds. Outcrops in talus downslope indicate a vertical extent of about 50 feet.

About 1,200 feet north of the limestone-breccia contact a group of tabular or veinlike bodies occurs in altered limestone and shows a close spatial relationship to felsite dikes (fig. 3). One vein (fig. 4), consisting of pyrite, galena, sphalerite (marmatite), and minor pyrrhotite in a gangue of white milky quartz, minor calcite, and unreplaced limestone fragments, follows the contact between limestone and a felsite dike. This vein is irregularly massive without marked banding and is oxidized to a dark chocolate brown. The vein pinches out upward into silicated limestone; the lower extension is covered by talus.

A few narrow discontinuous fissure veins consist of nearly solid argentiferous galena. These veins, however, pinch and swell irregularly and do not appear to have great continuity. The maximum width of massive galena in these veins is 10 inches, but most are between 2 and 6 inches across. A 20-foot chip sample (table 1, sample 10) across oxidized skarn (see fig. 3) containing narrow veins of galena assayed slightly more than 52 ounces of silver per ton. The walls of some of these veins are marked by brownish-yellow gouge. Preliminary examination of a polished section of sample 11 (see fig. 3; tables 1, 2), which contains 309.8 ounces of silver per ton,

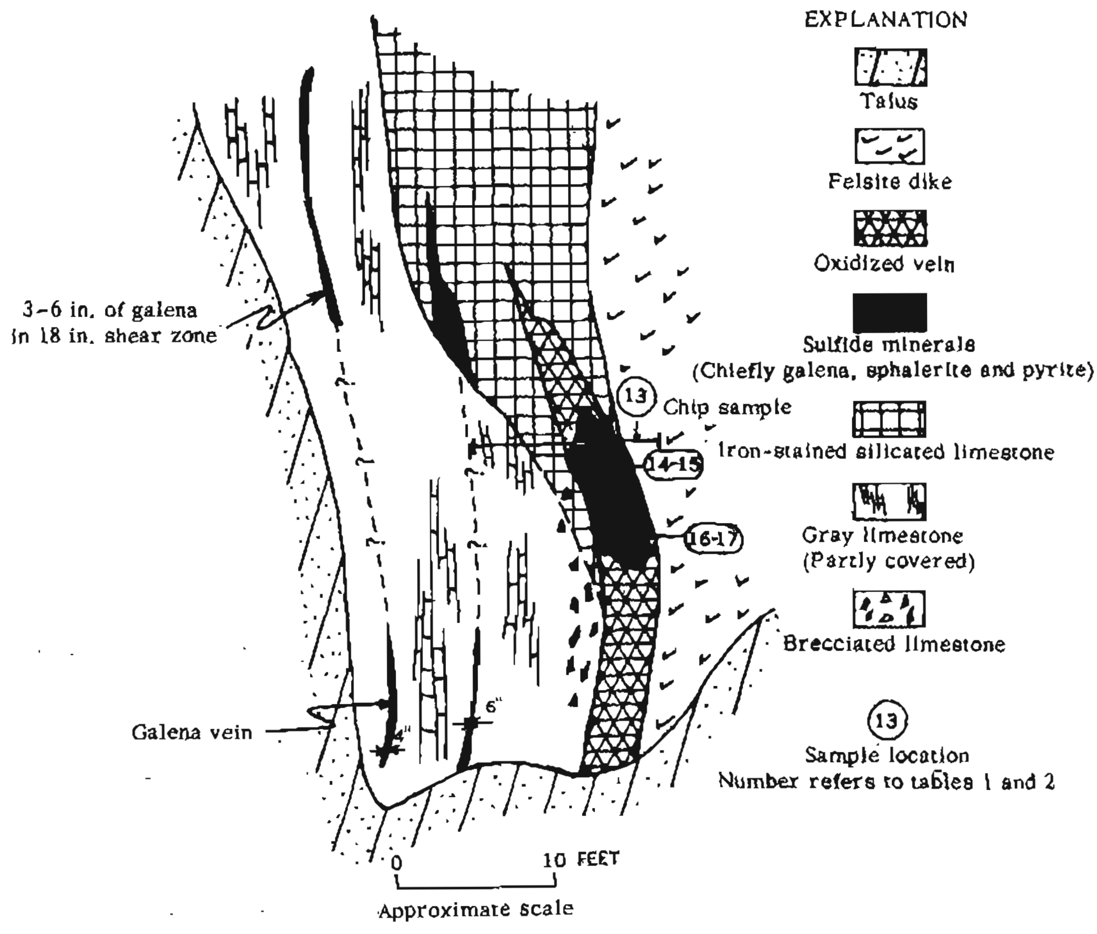

Figure 4.—Cliff face showing sulfide vein adjacent to felsite dike in area southwest of Bowser Creek.

shows that approximately 85-90 percent of the sample is galena. Other primary minerals include sphalerite, pyrite, and minor amounts of tetrahedrite. Small grains of other minerals, perhaps members of the copper-arsenic sulfide group of sulfo-salts (Arthur Radtke, oral commun., 1968), also are present. Secondary minerals developed along galena cleavages include cerussite, hematite, and mimetite(?).

Area northeast of Bowser Creek.—The deposits northeast of Bowser Creek (figs. 2, 5) show a close spatial association with the small granodiorite porphyry body or with felsite dikes. A description of the deposits examined and analyses for gold, silver, copper, lead, and zinc of samples collected from them are given in table 3.

Much of the area shown as limestone in figure 5 is covered by talus. However, mineralized skarn which appears to have potential economic significance locally crops out near the granodiorite porphyry and felsite dikes. The skarn typically consists of pyrrhotite and sphalerite (marmatite), associated with a variety of silicate minerals including epidote, clinopyroxene, quartz, and chlorite. The iron-bearing sulfide minerals weather to a deep reddish brown. There are scattered exposures of skarn in talus along the east side of the granodiorite porphyry. The skarn zones are as much as 25 feet across, and if they prove continuous beneath talus cover, then a north-trending skarn zone at least 1,000 feet long is indicated (fig. 5, samples 34-40).

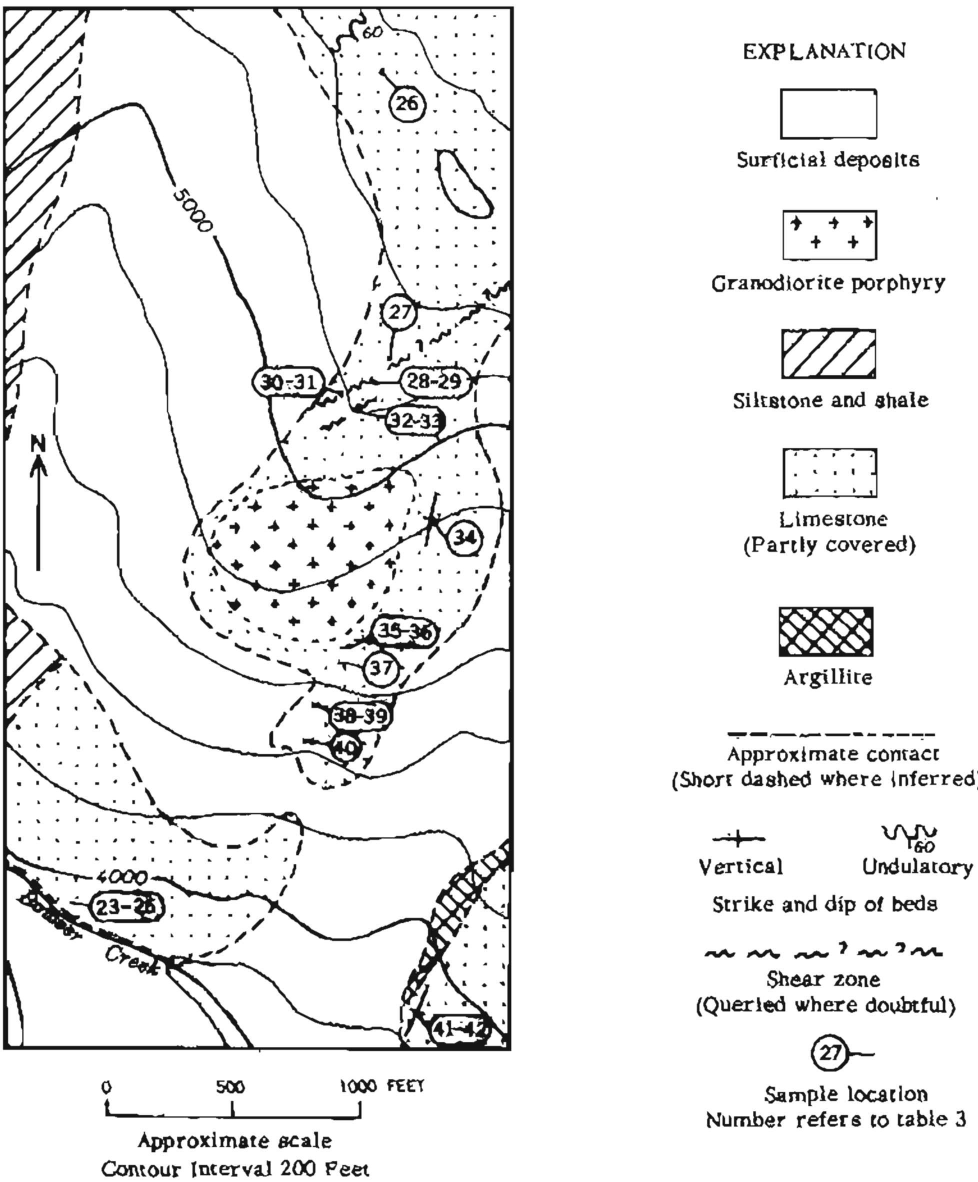

Figure 5.—Geology and location of samples on northeast side of Bowser Creek.

Other deposits in this area occur along shear zones which border felsite dikes (table 3, samples 27–33). The sulfide minerals replace limestone, and locally the dikes are partly replaced. Most deposits are narrow and discontinuous and pinch out within a few feet (fig. 6).

Deposits in Breccia

Small fractures filled with pyrrhotite and sphalerite occur in the northern igneous breccia body. Individual deposits appear to be small, but poor exposures prevent delineation of their true extent. The fracture fillings may represent only part of a more extensively mineralized breccia mass.

Area at head of Bowser Creek.—Deposits in igneous breccia were examined only along the headwaters of Bowser Creek (fig. 7). Descriptions of the individual localities and analyses of samples from these localities are given in table 4 (samples 43–58). The deposits consist of small sulfide veins largely controlled by northwest-trending fractures in igneous breccia (fig. 7). Specks and clots of a sulfide mineral (pyrrhotite?) also are disseminated in the breccia. The veins have steep to vertical dips and strike N. 40°–60° W. Significant replacement of the breccia does not appear to have occurred, because in many places vein walls match. None of the veins exceed 2 feet in width, and some veins end abruptly. Surficial deposits prevent tracing the veins for more than 10 feet. The veins consist of pyrrhotite with minor sphalerite (marmatite), chalcopyrite, and a trace of galena. One 4- to 6-inch vein (table 4, sample 54) contains 85 percent of sphalerite. Although the pyrrhotite has little current economic value, further exploration in this area may find significant concentrations of sphalerite.

Other Deposits

The locations of other scattered occurrences north and west of Bowser Creek are shown in figure 2. Semiquantitative spectrographic analyses of samples from these localities and a brief description of the samples are given in table 4 (samples 59–64). Of particular interest are samples 63 and 64 from the ridge west of Bowser Creek. Although the outcrops are small, and deposits are consequently of unknown extent, they do suggest that lead-zinc-silver mineralization extends for at least one-half mile southwest of the area shown in figure 3.

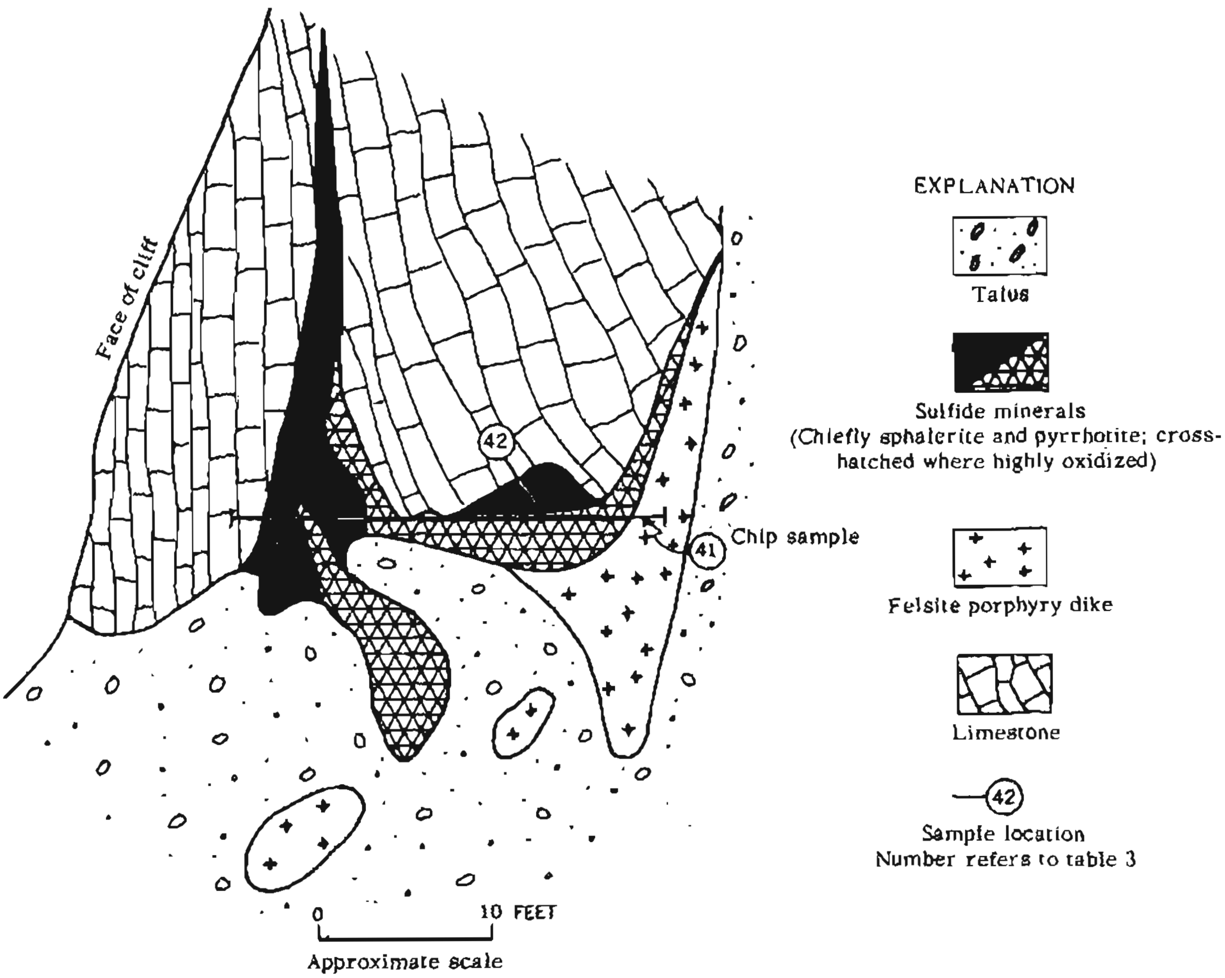

Figure 6.—Sulfide bodies at sample location 41–42 (fig. 5); looking northeast at small cliff.

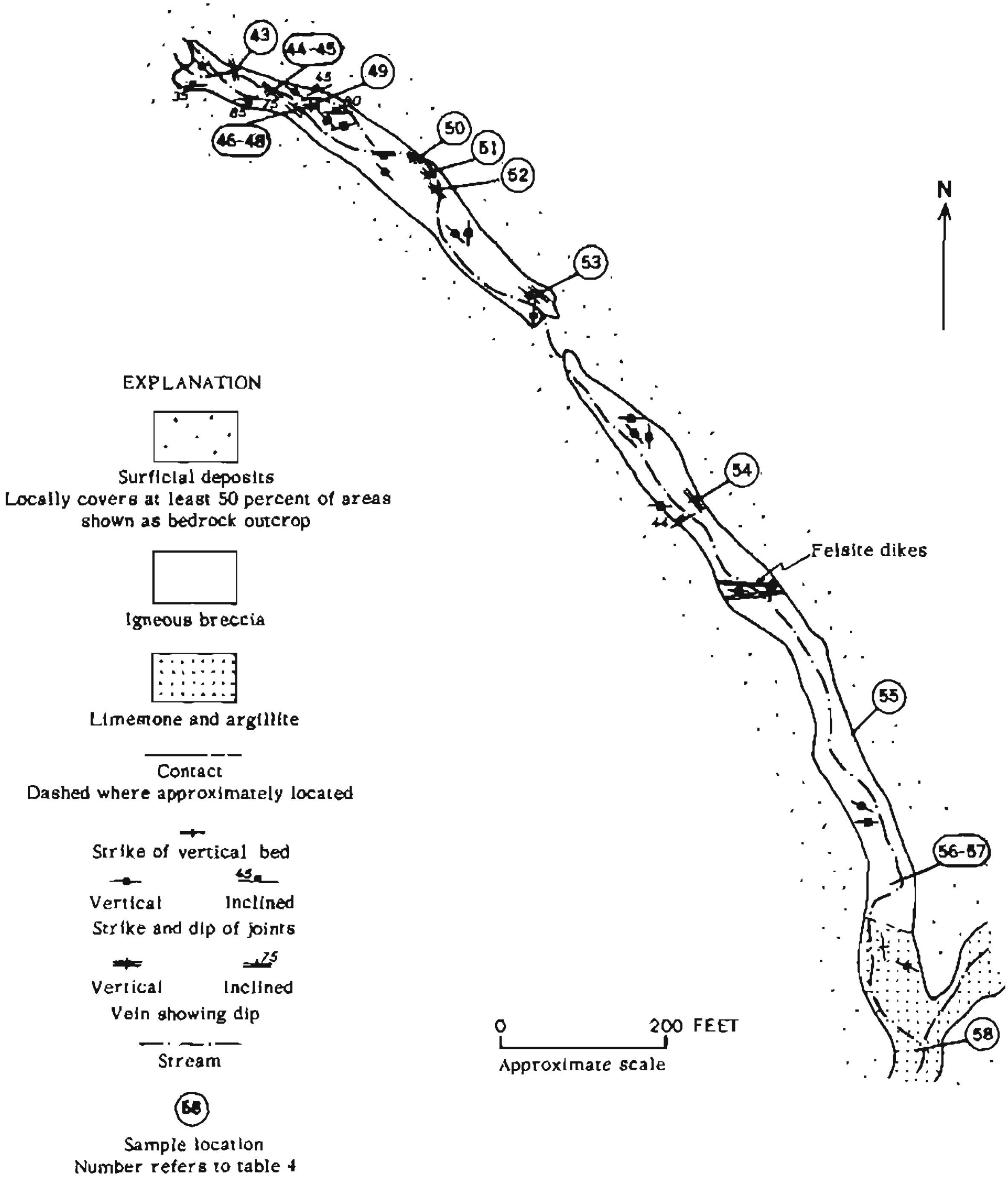

Figure 7.—Geology and location of samples at the headwaters of Bowser Creek.

SUMMARY AND SUGGESTIONS FOR PROSPECTING

Metalliferous deposits in the Bowser Creek area occur as replacement bodies (skarn) and fissure veins in limestone and as fracture fillings in igneous breccia. Ore minerals in the replacement bodies and fissure veins are sphalerite and argentiferous galena. These deposits occur near igneous breccia and granodiorite porphyry. In many places the sulfide deposits are adjacent to felsite dikes.

Fracture fillings in igneous breccia consist of pyrrhotite and sphalerite with minor chalcopyrite and galena. The exposed veins are controlled by northwest-trending fractures and do not exceed 2 feet in width.

Most of the deposits are sporadic and discontinuous, but the number of occurrences with locally high metal concentrations, their possible continuity beneath surficial deposits, and a favorable geologic environment (limestone cut by granitic intrusive rocks) suggest that the area has an economic potential for base- and precious-metal deposits that merits further investigation.

The most attractive sites for exploration in the Bowser Creek area are near the intrusive bodies. Although no sulfide deposits were found at the contact between the limestone and the southern intrusive breccia (fig. 2), the high copper, lead, zinc, and silver values from soil samples (fig. 3 and table 2, samples 1 and 2) suggest the presence of concealed base-metal and silver minerals. Widespread iron staining on the southwest side of this intrusive body and north of and along the steep walls at the headwaters of Bowser Creek have not been investigated and should be of interest to the prospector. Northeast of Bowser Creek, the small body of granodiorite porphyry, with its associated mineralized skarn, the pyrrhotite-sphalerite fracture fillings in the northern intrusive breccia (fig. 7), and the replacement and vein deposits shown in figure 3 all appear to warrant physical exploration to further define the extent and tenor of known sulfide occurrences. The mineralized bodies examined to date are locally rich, but their exploration may be vexatious because apparently they are small, terminate abruptly, and are capriciously distributed. Soil and stream-sediment sampling should serve as useful guides to other areas of mineralization in the district.

REFERENCE CITED

Brooks, A. H., 1911, The Mount McKinley region, Alaska, with descriptions of the igneous rocks and of the Bonnifield and Kantishna districts, by L. M. Prindle: U.S. Geol. Survey Prof. Paper 70, 234 p.

TABLES 1-4

Table 1.--*Analyses of bedrock samples from the southwest side of Bowser Creek*

[Analysts: W. D. Goss, Claude Huffman, Jr., J. A. Thomas, L. B. Riley, and V. E. Shaw. Gold determined by fire assay, silver by atomic absorption and gravimetric fire assay, lead and copper by atomic absorption, and zinc by atomic absorption and gravimetric analysis]

Sample No.	Lab. No.	Field No.	Au (ppm)	Ag (oz per ton)	Cu	Pb	Zn	Sample type[1]
					(percent)			
3	ACG854	67AMa251	0.03	2.4	0.11	0.09	5.95	8-1. Includes 3 ft of limestone.
4	ACJ015	R353A	.4	6.1	.49	.78	14.7	5-1. Continuation of sample 3.
5	016	R353B	.05	3.9	.32	.14	7.42	Selected.
6	017	R354A	.06	2.4	.04	.09	2.55	5-1
7	018	R354B	<.02	.4	.01	.03	.61	5-1. Continuation of sample 6.
8	019	R354C	.03	.9	.08	.03	[2] .48	8-1. Continuation of sample 7.
9	ACG853	Ma250	.02	.2	.01	.02	[2] .22	30-1. Includes 5 ft of limestone.
10	852	Ma249	<.02	[3] 52.2	.11	27.2	1.59	20-1
11	698	R311I	.2	[3] 309.8	.14	60.0	2.17	Selected.
13	850	Ma248A	.05	1.9	.19	.2	3.18	12-1. Includes 2 ft of dike.
14	ACJ054	R311D	<.02	[3] 56.3	.25	39.0	5.70	Selected.
18	ACG851	Ma248B	.03	[3] 20.5	.07	16.0	3.72	20-1
22	ACJ014	R351	.4	2.4	.15	.17	4.3	5-1

[1]Unless noted, samples are chip samples. First number is length in feet and second number is interval between chips in feet; that is, 8-1 is an 8-ft-chip sample with chips collected every foot.

[2]Analyses by atomic absorption.

[3]Gravimetric fire assay.

DESCRIPTION OF SAMPLES

Samples 3-5. 10-ft-wide massive skarn zone adjacent to limestone. Skarn consists of brecciated silicated limestone (quartz, clinopyroxene, minor epidote) replaced by sphalerite and pyrrhotite. Sulfide minerals make up 50-90 percent of zone. Outcrops in talus downslope indicate a vertical extent of about 50 ft.

Samples 6-8. Silicated limestone with discontinuous stringers and pods of sulfide minerals (sphalerite, pyrrhotite); highly oxidized.

Sample 9. Taken across oxidized skarn (quartz, clinopyroxene, epidote); no fresh sulfide minerals visible in outcrop.

Sample 10. Taken about 50 ft below sample 9 across oxidized skarn adjacent to felsite dike (quartz, plagioclase, potassium feldspar). Shear zones in skarn locally contain thin stringers and lenses of galena from 1 to 10 in. thick. Lenses of pyrite, galena, and minor sphalerite as much as 2 ft wide also occur sporadically in skarn; pinch out to thin stringers over a vertical distance of a few feet.

Sample 11. A selected sample of galena from shear zone.

Sample 13. Highly oxidized vein of pyrite, galena, sphalerite, and minor pyrrhotite 3-5 ft wide between felsite dike and limestone; oxidized capping of vein exposed over a vertical distance of about 40 ft, lower extension covered by talus, pinches out upward (fig. 4). Location of samples about 75 ft below sample 10.

Sample 14. A selected sample of pyrite and galena with minor sphalerite, quartz, and calcite from widest part of vein.

Sample 18. Taken across silicated limestone (quartz, clinopyroxene, calcite): Replacement by galena occurs along small shear zones in limestone; lenses of pyrite, galena, and minor sphalerite also occur sporadically in limestone.

Sample 22. Stringers and lenses of oxidized sulfide minerals (pyrite, galena, and sphalerite) in skarn adjacent to felsite dike; mineralized zone pinches out upward, lower part covered by talus.

Table 2.--Semiquantitative spectrographic analyses and gold analyses of soil and bedrock samples from the southwest side of Bowser Creek

[Analysts: A. L. Sutton, Jr., Arnold Farley, Jr., spectrographic; A. L. Meier, R. L. Miller, and T. A. Roemer, gold-atomic absorption. Spectrographic analyses reported in parts per million to the nearest number in the series 0.5, 0.7, 1.0, 1.5, 3.0, 5.0, 7.0, 10, 15, and so on, which represent approximate midpoints in a geometric scale. The precision of a reported value is approximately plus 100 percent or minus 50 percent. See figure 3 for location of samples. Symbols used: >=greater than; <=detected, but below limit of determination; A=not detected; I=interference; ND=not determined; M=>10 percent]

Sample No.	Lab No.	Field No.	Ag	As	Au	B	Ba	Be	Co	Cr	Cu	La	Mn	Mo	Nb
1	ACJ072	67AR352	20	A	<0.02	ND	15	2	200	3	10,000	A	50,000	A	A
2	073	353	70	A	.02	ND	7	2	150	15	10,000	A	10,000	A	A
11	ACG687	R311I	>1,000	>10,000	.05	70	100	<1	<10	A	1,500	<20	1,500	7	<20
12	686	311H	>1,000	300	.06	10	<100	<1	<10	A	2,000	<20	300	<5	<20
14	682	311D	>1,000	700	.04	<10	<100	<1	<10	A	2,000	<20	1,500	<5	<20
15	683	311E	700	>10,000	.04	50	100	<1	20	A	700	<20	700	I	<20
16	684	311F	150	<200	.05	70	<100	<1	100	A	2,000	<20	1,000	I	<20
17	685	311G	30	<200	.06	100	<100	<1	100	A	1,500	<20	700	I	<20
19	680	311B	70	<200	1.0	50	<100	<1	150	10	3,000	<20	2,000	7	<20
20	681	311C	200	<200	.04	<10	<100	<1	10	A	50	<20	2,000	<5	<20
21	679	311A	.7	<200	.02	30	<100	<1	<10	A	150	<20	1,000	<5	<20
Limit of detectibility:															
Samples 1 and 2			1	2,000	.02	ND	2	1	3	1	1	30	1	3	10
Samples 11-20			.5	200	.02	10	20	1	10	5	2	20	20	2	10

Sample No.	Ni	Pb	Sc	Sr	V	Y	Zn	Zr	Ca (percent)	Fe (percent)	Mg (percent)	Ti (percent)	Sample type
1	50	7,000	ND	10	A	A	M	A	1.0	1.5	0.7	0.02	Soil
2	30	15,000	ND	30	20	A	100,000	15	1.0	1.0	.7	.05	Soil
11	<2	>5,000	<5	<10	<10	15	>10,000	<20	.7	15	.03	.015	Selected.
12	<2	>5,000	<5	<10	<10	<5	>10,000	<20	<.05	7	<.02	.001	Selected.
14	<2	>5,000	<5	<10	<10	<5	>10,000	<20	.5	7	<.02	.02	Selected.
15	<2	>5,000	<5	<10	<10	<5	>10,000	<20	.07	20	<.02	.007	Selected.
16	10	3,000	<5	10	10	7	>10,000	<20	.15	>20	<.02	.02	Selected.
17	10	1,500	<5	15	15	7	>10,000	<20	.3	>20	.03	.03	Selected.
19	<2	300	<5	30	30	5	>10,000	70	10	15	.7	.07	Grab.
20	2	>5,000	<5	20	20	5	>10,000	70	15	7	.3	.03	Selected.
21	<2	30	<5	10	10	15	500	<20	7	5	.2	.02	Grab.
Limit of detectibility:													
Samples 1 and 2	3	10	ND	5	7	10	200	10	.005	.001	.005	.0002	
Samples 11-20	2	10	5	50	5	5	200	10	.05	.05	.02	.002	

DESCRIPTION OF SAMPLES

Sample 1. From brown horizon 12 in. below surface.
Sample 2. From 2-in. greenish-gray horizon below sample 1.
Samples 11, 12. Galena from shear zone in silicated limestone. For assay and description see samples 10 and 11 in table 1.
Samples 14, 15. Pyrite and galena with minor sphalerite, quartz, and calcite. For assay and further description see sample 14 in table 1.
Samples 16, 17. Sphalerite with minor galena and pyrrhotite. For description of vein see sample 13 in table 1.
Sample 19. Oxidized skarn.
Sample 20. Skarn containing galena and sphalerite. For further description see sample 18 in table 1.
Sample 21. Felsite dike that cuts silicated limestone.

Table 3.--Analyses of bedrock samples from the northeast side of Bowser Creek

[Analysts: W. D. Goss, Claude Huffman, Jr., J. A. Thomas, L. B. Riley, and V. E. Shaw. Gold determined by fire assay; silver by atomic absorption, lead and copper by atomic absorption, and zinc by atomic absorption and gravimetric analysis]

Sample No.	Lab. No.	Field No.	Au (ppm)	Ag (oz per ton)	Cu (percent)	Pb (percent)	Zn (percent)	Sample type[1]
23	ACG595	67AEr245	0.3	3.5	2.44	0.02	4.02	3-.5. Includes 18 in. to 2 ft of limestone.
24	596	Er246	.07	1.9	.65	.02	1.04	3-.5. Includes 18 in. to 2 ft of limestone.
25	597	Er247	.2	5.6	1.10	.05	4.72	3-.5. Includes 18 in. to 2 ft of limestone.
26	700	R327	<.02	11.5	.02	24.0	.16	Selected.
27	ACJ001	R328	.02	1.2	.07	.15	5.95	Selected.
28	002	R329A	.5	.5	.03	.04	4.83	3-.5
29	003	R329B	.7	3.0	.55	.26	22.1	Selected.
30	004	R330A	<.02	.9	.02	1.55	2.96	5-.5
31	005	R330B	.03	3.7	.07	11.5	18.7	Selected.
32	006	R331A	<.02	.1	.03	.01	[2].03	5-.05.
33	007	R331B	.2	2.2	.96	.06	12.2	Selected.
34	008	R333A	1.1	1.6	.08	.48	7.44	5-1
35	009	R334A	3.4	.5	.02	.02	2.88	5-1
36	010	R334B	.8	.6	.05	.03	4.76	8-1. Continuation of sample 35.
37	011	R335	.7	.5	.02	.04	4.55	5-1
38	012	R336A	2.0	.5	.04	.02	14.5	10-1
39	013	R336B	1.6	.4	.02	.17	4.3	15-1. Continuation of sample 38.
40	ACG856	Ma254	.2	1.6	.06	.08	7.46	15-1
41	855	Ma252	.02	3.7	.13	.24	4.97	25-1. Includes 2 ft of limestone and 2 ft of dike.
42	ACJ020	R356	.03	10.1	.33	2.1	8.55	Selected.

[1]Unless noted samples are chip samples. First number is length of chip in feet, and second number is interval between chips in feet; that is, 8-1 is an 8-ft-chip sample with chips collected every foot.
[2]Analyses by atomic absorption

DESCRIPTION OF SAMPLES

Samples 23-25. Irregular lensatic sulfide bodies (sphalerite with minor chalcopyrite, pyrite) in silicated limestone (clinopyroxene with subordinate epidote, quartz, and calcite) along discontinuous fractures. Limestone cut by felsic and mafic dikes.

Sample 26. Sporadic 2- to 3-in.-wide lenses of galena as much as 1 ft long in skarn adjacent to felsite dike. Mineralized within 1 ft of dike.

Samples 27-31. Shear zone (strike N. 55° W., dip 75° NW.) adjacent to felsite dike that cuts limestone. Sphalerite, galena, and minor chalcopyrite localized along shear as small pods and stringers; sulfide minerals replace both skarn (epidote, calcite, quartz, and chlorite) and dike. Maximum width of pods is 20 in.; most pods pinch out within 10 ft along dip of shear.

Samples 32, 33. 18-in.-wide lens of sphalerite in skarn along shear zone; shear exposed for 6 ft along dip.

Sample 34. Silicated limestone with veins of sphalerite and pyrrhotite 4-5 in. wide in limestone (strike N. 10° E., dip 90°). Outcrop is 8 ft wide, 25 ft long; extensions covered by talus. About 100 ft downslope to south a similar small outcrop with minor content of sulfide minerals.

Samples 35, 36. Poorly exposed outcrop of oxidized skarn isolated by talus.

Sample 37. Small outcrop of skarn with sphalerite and pyrrhotite; isolated by talus.

Samples 38, 39. Poorly exposed small outcrops of skarn (chiefly sphalerite, pyrrhotite, quartz, clinopyroxene, and epidote); pods of sphalerite and pyrrhotite as much as 10 in. wide.

Sample 40. Body containing 40-80 percent sulfide minerals (chiefly sphalerite and pyrrhotite) about 4 ft by 20 ft in skarn; body pinches out downward; may extend upward to sample 38.

Samples 41, 42. Zone of sulfides 10 in. to 4 ft wide in skarn adjacent to felsite dike. A 5-ft-wide vein of sphalerite and pyrrhotite extends upward from sulfide-rich skarn zone for about 30 ft--pinches out (fig. 6). Lower part of skarn zone and dike covered. Mineralized skarn zone contains about 75 percent sphalerite and pyrrhotite in a ratio of about 1:1. Silicated limestone contains quartz, epidote, calcite, and minor chlorite (sample taken 5 ft from sulfides). Chip sample taken across mineralized skarn zone and dike.

Table 4.--Semiquantitative spectrographic analyses and gold analyses

[Analysts: A. L. Sutton, Jr., Arnold Farley, Jr., spectrographic; A. L. Meier, R. L. Miller, and the nearest number in the series 0.5, 0.7, 1.0, 1.5, 3.0, 5.0, 7.0, 10, 15, and so on, which proximately plus 100 percent or minus 50 percent. See figures 2, 7 for location of samples. I=interference; M=>10 percent]

Sample No.	Lab. No.	Field No.	Ag	As	Au	Ba	Be	Co	Cr	Cu	La	Mn
43	ACQ587	67AEr232	10	A	0.07	3,000	A	50	5	500	A	100
44	588	233A	20	A	.02	2,000	A	50	3	1,500	A	300
45	589	233B	70	A	.04	500	A	150	1	10,000	A	1,000
46	590	234A	20	A	.02	3,000	A	50	10	1,500	30	300
47	569	210	100	A	.1	200	A	200	A	3,000	A	200
48	591	234B	100	100,000	.03	500	A	200	1	3,000	A	3,000
49	592	235	7	A	<.02	3,000	A	30	5	500	30	200
50	568	208	300	A	.08	50	A	100	A	20,000	A	2,000
51	567	207	100	A	.08	150	A	150	A	3,000	A	200
52	566	206	10	A	.06	500	A	200	1.5	2,000	A	50
53	593	238	5	A	<.02	3,000	A	7	7	200	20	3,000
54	565	205	200	A	.1	20	A	500	1.5	30,000	A	2,000
55	564	203	200	7,000	.05	3,000	A	150	5	15,000	20	2,000
56	562	202A	A	A	.04	1,500	1	7	7	15	20	300
57	563	202B	A	A	.04	1,000	1.5	10	30	50	30	700
58	594	244	A	A	.03	1,500	A	20	70	200	30	3,000
59	966	67ABu195	50	A	<.02	700	A	15	50	150	20	2,000
60	570	67AEr215	30	A	<.02	100	A	7	5	200	A	15,000
61	571	67AEr217	100	A	.05	7	1.5	100	70	30,000	50	5,000
62	572	67AEr218	100	A	.05	20	1.5	50	7	20,000	A	5,000
63	904	67ABu131	300	1,500	.06	30	A	7	2	1,500	A	50,000
64	905	67ABu132	5,000	30,000	.08	50	A	A	15	1,500	A	1,000

[1]Unless noted samples are chip samples. First number is length of chip in feet, and second number is

DESCRIPTION OF SAMPLES

Samples 43-49. Veins of pyrrhotite with minor chalcopyrite and sphalerite in igneous breccia. Veins show strong localization along N. 40°-60° W. fractures. There is no replacement of wallrock--in many places opposite sides of vein match. Lack of continuous exposure prevents tracing of veins for more than 10 ft, and except where noted, lengths of veins are defined by surficial cover. Some veins pinch and swell and may end abruptly. Sample 43: 2-3 in. wide and 4 ft long; pinches out on one end. Samples 44-45: 2 ft wide and 8 ft long. Samples 46-48: 2 ft wide and 10 ft long; probably a continuation of vein 48. Sample 49: 3-5 in. wide and 8 ft long.

Samples 50-52. Narrow northwest-trending veinlets of pyrrhotite, sphalerite, and minor chalcopyrite in igneous breccia. Sample 50: 2 in. wide; 40 percent pyrrhotite, 30 percent sphalerite, 10 percent chalcopyrite, trace of galena, 20 percent quartz. Sample 51: 8 in. wide; pyrrhotite with subordinate chalcopyrite and sphalerite. Sample 52: 3-8 in. wide; chiefly pyrrhotite.

Sample 53. Narrow (1 in. wide) northwest-trending veinlets of pyrrhotite in igneous breccia.

Sample 54. 4- to 6-in.-wide northwest-trending vein of sulfides in igneous breccia; 85 percent sphalerite, 5 percent chalcopyrite, 5 percent pyrrhotite, 5 percent gangue.

of bedrock samples near the headwaters of Bowser Creek

T. A. Roemer, gold-atomic absorption. Spectrographic analyses reported in parts per million to represent approximate midpoints in a geometric scale. The precision of a reported value is ap-
Symbols used: > =greater than; < =detected, but below limit of determination; A=not detected;

Mo	Nb	Ni	Pb	Sr	V	Y	Zn	Zr	Ca (percent)	Fe (percent)	Mg (percent)	Ti (percent)	Sample[1] type
<5	A	5	200	500	50	15	A	100	0.15	7	0.1	0.15	3-.5
<5	A	5	200	200	30	10	A	70	.2	M	.1	.15	5-.5
<5	A	10	1,000	20	A	A	30,000	15	.15	M	.03	.01	Selected.
<5	A	7	150	500	50	15	1,000	100	.2	10	.15	.2	5-.5
<5	A	10	700	7	A	A	3,000	A	.01	M	.01	.015	Selected.
<5	A	15	3,000	20	A	A	M	20	.03	M	.02	.03	Selected.
<5	A	7	100	500	50	10	500	100	.3	5	.3	.2	3-.5
<5	A	7	3,000	10	A	A	100,000	A	.5	M	.02	.002	Grab.
<5	A	7	1,000	7	A	A	2,000	A	.02	M	.01	.005	Grab.
<5	A	50	30	30	10	A	5,000	A	.15	M	.01	.01	Grab.
3	A	5	150	500	50	15	2,000	150	2	2	.7	.2	3-.5
<5	A	15	50	A	A	A	M	A	.1	M	.2	.001	Grab.
<5	A	5	700	500	30	A	M	50	.7	M	.07	.15	Selected.
A	10	7	20	500	70	30	A	100	3	1.5	.7	.15	Grab.
A	10	15	50	700	100	20	1,000	150	5	1.5	1.5	.15	Grab.
A	A	20	15	500	70	20	A	200	5	3	2	.5	3-.5
<5	10	100	10,000	20	50	10	5,000	100	.05	M	1	.2	Selected.
A	A	15	7,000	1,000	A	10	20,000	A	M	5	3	.01	Selected.
<5	A	50	500	70	70	30	5,000	100	3	10	5	.2	Selected.
<5	A	100	30	100	100	10	2,000	A	5	10	2	.015	Selected.
<5	A	15	M	70	A	A	50,000	A	.07	M	.05	.015	Selected.
<5	A	7	M	30	15	A	30,000	10	.15	10	.07	.05	Selected.

interval between chips in feet; that is, 5-.5 is a 5-ft-chip sample with chips collected every one-half foot.

DESCRIPTION OF SAMPLES

Sample 55. Small breccia zone 3-4 in. wide consisting of angular fragments of silicated limestone and felsite cemented by sphalerite with minor chalcopyrite and pyrrhotite. Sulfides make up about 30 percent of rock.
Samples 56, 57. Igneous breccia containing less than 5 percent of disseminated specks and clots of sulfide minerals. Samples taken within 50 ft of breccia-limestone contact.
Sample 58. Discontinuous narrow (8-10 in. wide) oxidized zone of pyrrhotite and sphalerite in silicated limestone.
Sample 59. Pyritized mafic dike.
Sample 60. Narrow mineralized shear zone; highly oxidized.
Sample 61. 3-ft-wide mineralized shear(?) in altered, highly oxidized argillite (pyrite with minor chalcopyrite).
Sample 62. Small outcrop of mafic rock with disseminated pyrite, pyrrhotite, and sphalerite.
Sample 63. Iron oxide-stained shear zone in limestone.
Sample 64. Narrow vein of galena (2-6 in. wide) in limestone--poorly exposed, extent unknown.

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