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report of investigations 6141

TRENCHING AND SAMPLING OF THE RHYOLITE MERCURY PROSPECT, KUSKOKWIM RIVER BASIN, ALASKA

By Raymond P. Maloney

UNITED STATES DEPARTMENT OF THE INTERIOR

BUREAU OF MINES

1962

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UNITED STATES DEPARTMENT OF THE INTERIOR
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TRENCHING AND SAMPLING OF THE RHYOLITE MERCURY PROSPECT, KUSKOKWIM RIVER BASIN, ALASKA

by

Raymond P. Maloney[1]

ABSTRACT

The Rhyolite mercury prospect is on the south flank of Juninggulra Mountain--a large rhyolite intrusive in the Kuskokwim River region about 36 airline miles northwest of Red Devil, Alaska. Bulldozer trenching by the Bureau of Mines exposed bedrock at intervals in a 2,000- by 3,000-foot area where previous prospecting by the owners had disclosed abundant float and several in-place stringers containing cinnabar in widely varying amounts. The additional trenching indicated that the mercury mineralization in the limited area investigated was confined to erratically distributed short stringers and to small lenses, occurring in discontinuous zones in numerous silica-carbonate dikes and sills or along their altered contacts with sedimentary rocks. The geologic relationship of the mercury-bearing silica-carbonate dikes and the nearby rhyolite intrusive is similar to that existing at several other mercury mines and prospects in the Kuskokwim region. The depth of overburden and the presence of permafrost were serious obstacles to bulldozer trenching, and only a comparatively small part of the mineralized area was thus investigated.

INTRODUCTION

Reports by the Bureau of Mines and the Geological Survey (see bibliography at the end of this report preceding the appendix) and records of gold-placer operations indicate that mercury is widely distributed throughout the Kuskokwim River Basin. Most early discoveries of mercury in the region were made in the more accessible areas along the Kuskokwim River by prospectors searching for placer gold. The Rhyolite prospect, however, was discovered as the result of a deliberate search for mercury in an isolated area by prospectors familiar with the geology of the mercury deposits. Preliminary work was limited to shallow trenching. Further investigation was undertaken by the Bureau of Mines to indicate the mercury resource potential of an undeveloped but geologically favorable area. This report describes the results of trenching and sampling by the Bureau of Mines.

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ACKNOWLEDGMENTS

Appreciation is expressed to Robert Lyman of Red Devil, Alaska, and to Joe Struver of Moore Creek, Alaska, for information on the prospect.

HISTORY

In 1953, a few small stringers of cinnabar were found in rhyolite about 3 miles from Juninggulra Mountain. Robert Lyman and Joe Struver prospected the area in 1956 and discovered the Rhyolite prospect; in 1957, they did some bulldozer trenching and stream panning and dug numerous prospect pits with hand tools. In 1958, the prospect was briefly examined by the Bureau, and trenching operations were conducted during the summer and fall of 1959.

LOCATION AND ACCESSIBILITY

The Rhyolite prospect is on the south flank of Juninggulra Mountain in the Kuskokwim River Basin at latitude 61° 56' N. and longitude 158° 26' W. It is 35 airline miles southwest of Flat and 36 airline miles northwest of Red Devil (figs. 1 and 2).

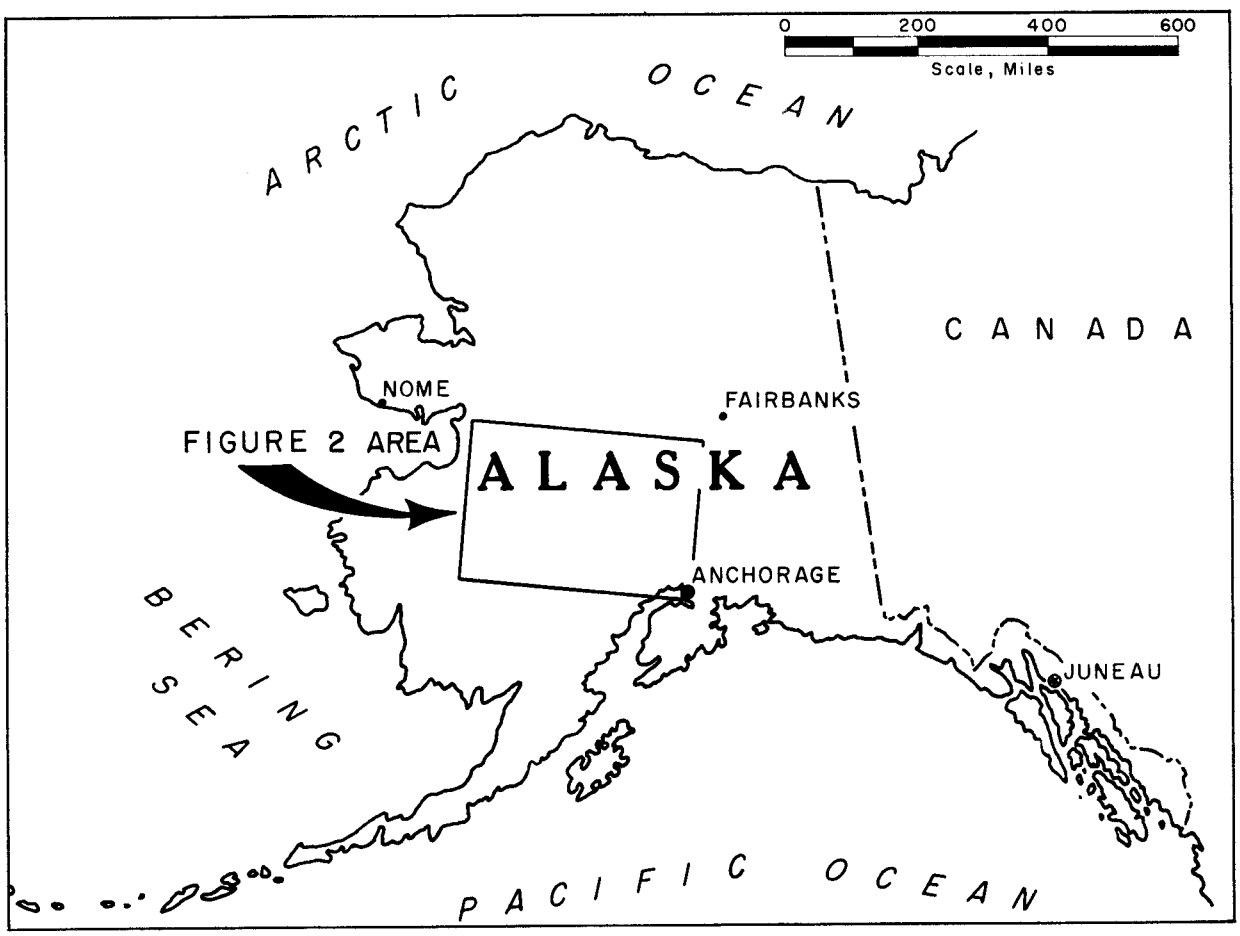

FIGURE 1. - Index Map of Alaska.

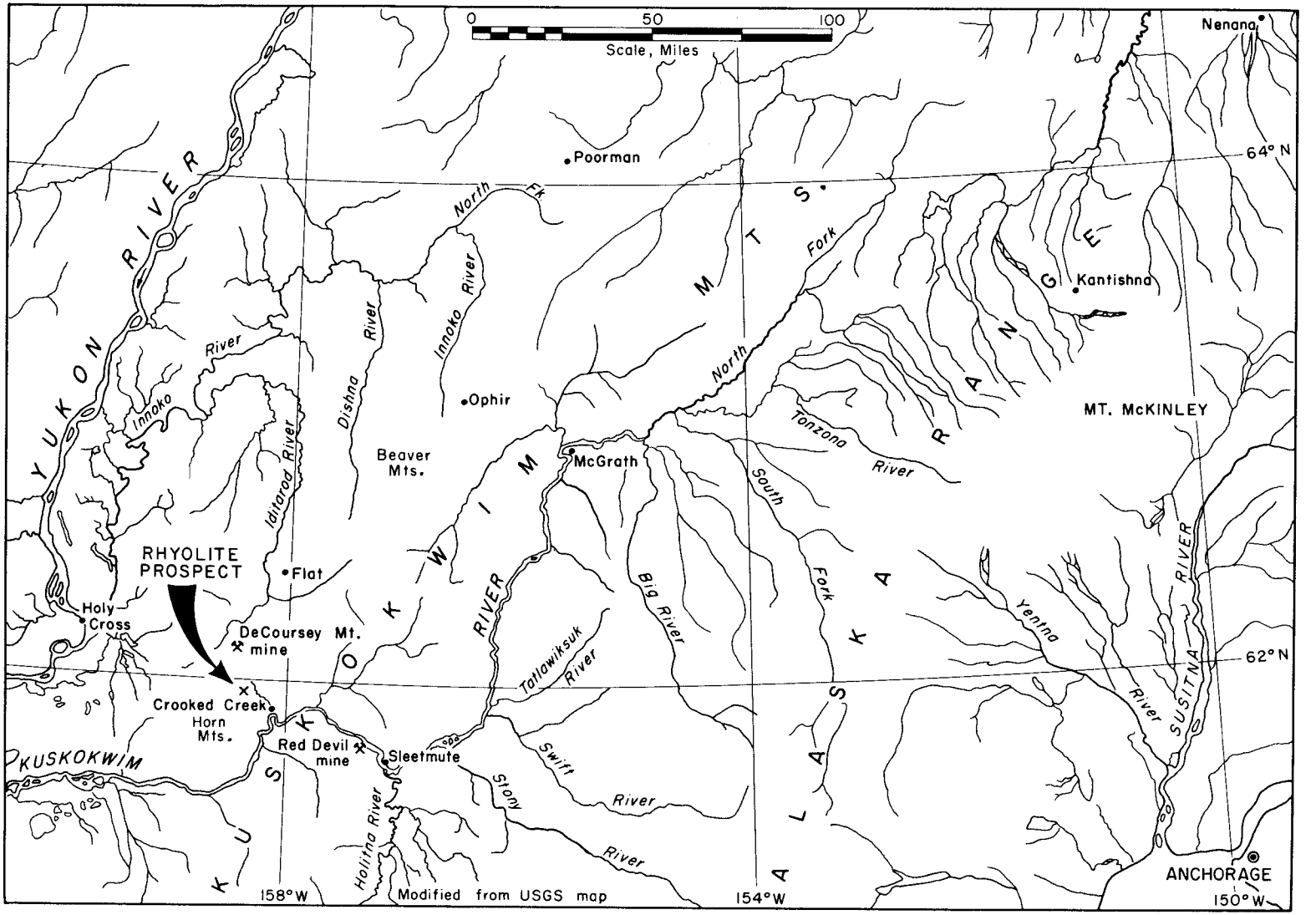

FIGURE 2. - Location Map, Rhyolite Prospect.

There are no roads or trails in this uninhabited and isolated area. Heavy equipment and supplies used on the project were tractor-freighted from Flat before the spring breakup when the ground was frozen and snow covered. An airstrip, suitable for the small, light planes used to bring in personnel and small supplies was leveled by the Bureau.

Airfields suitable for large, multiengine planes are maintained at Flat and at Red Devil; the Red Devil airfield serves the Red Devil mercury mine, which, in 1962, was the largest lode mining operation in Alaska. Crooked Creek and the DeCoursey Mountain mercury mine, 16 miles southeast and 9 miles north of Juninggulra Mountain, respectively, have airstrips suitable for small, single-engine planes.

River boats and large barges, operating on the Kuskokwim River from June to about the last of September, bring heavy freight, fuel oil, and mining equipment to a number of points along the river from Bethel, a port of ocean freighters. Supplies and equipment could be tractor-freighted from Crooked Creek during the summer months, but it is preferable that this be done before the spring breakup when greater loads can be hauled on the frozen ground.

PHYSICAL FEATURES AND CLIMATE

The Kuskokwim Mountains in the vicinity of the Rhyolite prospect are low, rolling hills and long, flat-topped ridges. Several isolated rhyolite intrusives have a distinctive dark color when seen from a distance because of a cover of black lichen, which grows preferentially on the weathered rhyolite. Juninggulra Mountain, the site of the Rhyolite prospect, is one of the larger of these rhyolite intrusives; it has an altitude of about 1,200 feet. The north flank of the Horn Mountains, an isolated group with a maximum altitude of 3,600 feet, is a few miles to the south.

Frozen overburden (permafrost), from 5 to 16 feet or more in depth, covers most of the area. Bedrock exposures are few, and they are generally near the crest of the ridges and hills. The lower slopes are covered with brush, dense growths of spruce, and some birch. Few trees reach 18 inches in diameter, and most are less than 12 inches in diameter. Spruce trees, only 3 to 4 inches in diameter, have from 50 to 100 growth rings. Dense, almost impenetrable alder thickets are found along the creekbeds.

Winters are long and cold, and the summers are short and comparatively warm. Precipitation is probably less than 20 inches per year. Permafrost is encountered in most of the area.

GENERAL GEOLOGY

The geology of the area has been mapped and described on a reconnaissance basis by Cady and others (2).[2] The following general description of the geology of the area is summarized from their reports.

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[2] Underlined numbers in parentheses refer to items in the bibliography at the end of this report preceding the appendix. Page references refer to pages in the items and not to pages in this report.

Most of the area is underlain by an extremely thick sequence (40,000 to 65,000 feet) of Cretaceous sedimentary rocks known as the Kuskokwim group. They are primarily interbedded shales and graywackes, with some sandstone, tuff, and conglomerate. Unconsolidated residual deposits and tuff, basalt flows, and rhyolite lava of Tertiary age form the north slope of the Horn Mountains and cover the contact between the Tertiary quartz monzonite stock of these mountains and the sedimentary beds.

Both extrusive and intrusive Tertiary rhyolite occur in the area. The rhyolite found on the north flank of the Horn Mountains is composed largely of tuff with some lava and is classified as an extrusive. The albite rholite at Juninggulra Mountain is classified as an intrusive and probably is hypabyssal; it occurs in sheets, sills, and dikes.

The basalt, found along the periphery of the Horn Mountains, is classified as a flow rock and probably is younger than the rhyolites, whereas the biotite basalt, of which dikes and sills are found at the Rhyolite prospect, is classified as a hypabyssal intrusive and probably is older than the rhyolites. This biotite basalt alters to a silica-carbonate, commonly associated with mercury mineralization.

DESCRIPTION OF THE DEPOSIT

Mercury occurrences in this section of the Kuskokwim River Basin have a similar geologic relationship. Cinnabar usually is associated with basalt dikes and sills, hydrothermally altered to silica-carbonate rock; only minor amounts have been found in the numerous albite-rhyolite intrusives of the basin. Cady and others (2), Webber and others (9), Rutledge (7), and Smith and Madden (8) describe in detail other known occurrences of mercury in the Kuskokwim River Basin.

From 5 to 16 feet of frozen overburden, composed mainly of clastic material, conceals most of the bedrock at the Rhyolite prospect; the crest and steeper slopes of Juninggulra Mountain are partially covered by a loose, barren mantle of broken and weathered rhyolite. Interbedded shale, sandstone, graywacke, and tuff, intruded by basalt, silica-carbonate (altered basalt), and rhyolite, occur in the immediate area (fig. 3);(2, pp. 50-54, 69, 78-80).

Bedrock observation at the prospect was limited to that exposed in trenches excavated within a 2,000- by 3,000-foot area (fig. 4). Here a number of silica-carbonate dikes and sills intrude sedimentary beds, which dip about 80° N. and strike about N. 70° E. Only minor faulting of the dikes and sills was evident, and intrusion probably occured after the uplift of the sedimentary beds; offsets and abrupt endings of these intrusives were common, resulting in disconnected and erratically placed segments. Dike widths varied from a few inches to over 50 feet, but the thickness of the sills was not determined except in trench 1, where one sill was found to be about 10 feet thick. Alteration to silica-carbonate was generally complete; many of the dikes and sills were weathered to a yellow-brown color, whereas others had the fresh light-gray color of unweathered material. Both weathered and unweathered silica-carbonate were found in all parts of the trenched area.

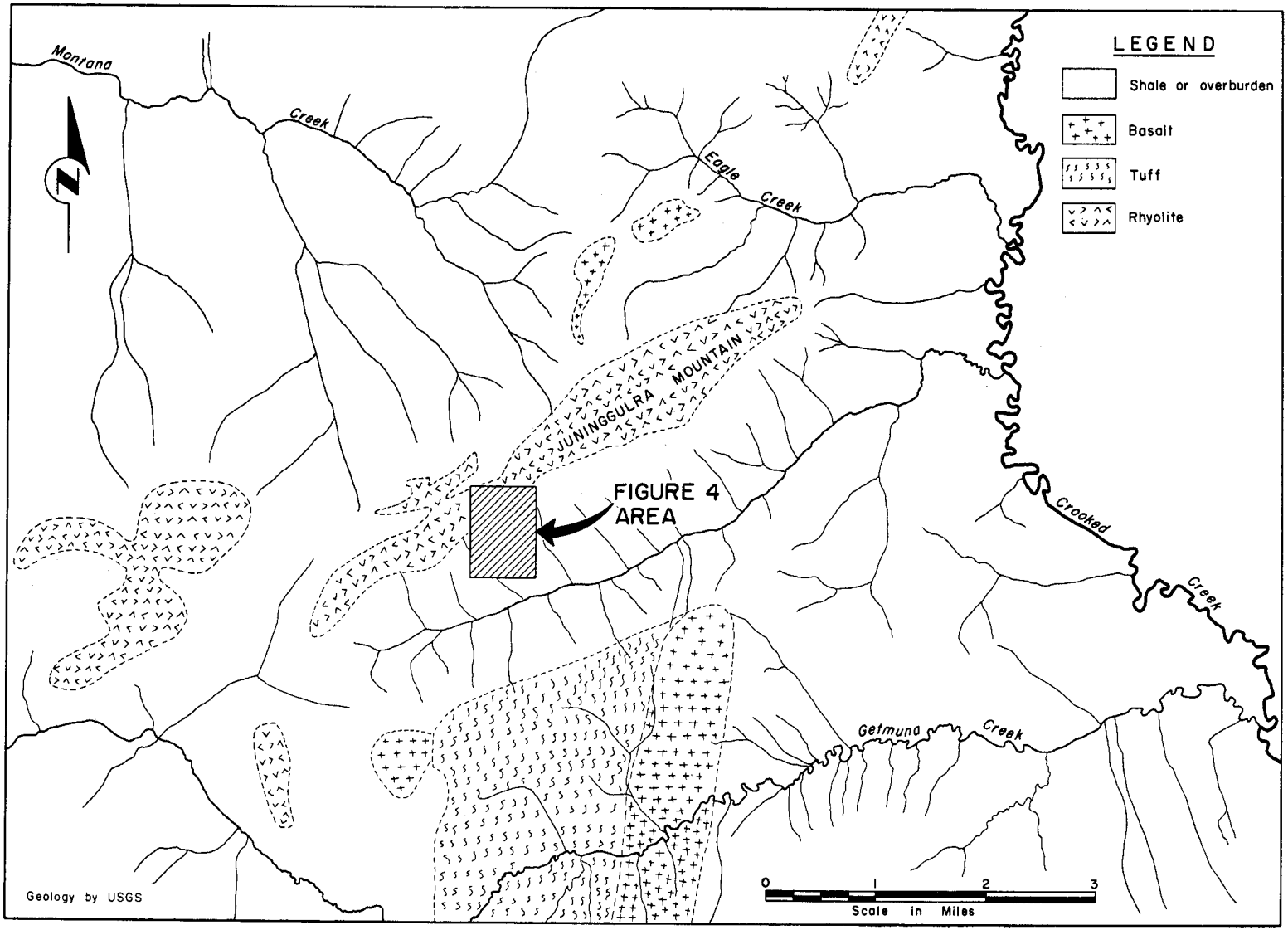

FIGURE 3. - Geologic Map of Rhyolite Prospect Area.

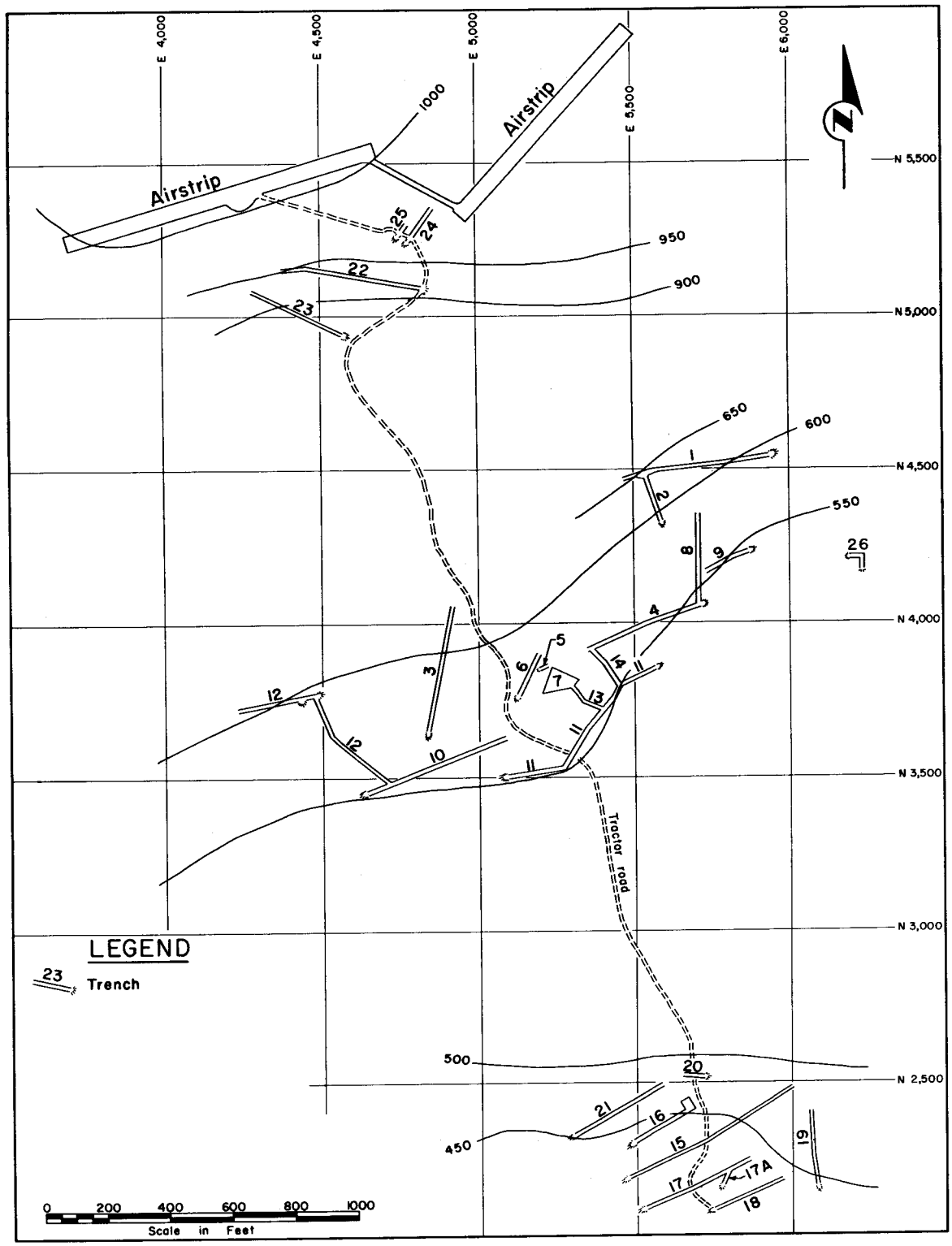

FIGURE 4. - Plan of Trenches, Rhyolite Prospect.

Mercury mineralization was introduced as cinnabar in the silica-carbonate dikes and sills and in much lesser amounts in the adjacent, altered sedimentary rocks; the degree of weathering of the silica-carbonate had no connection with the amount of mineralization. Neither altered nor unaltered basalt intruded the rhyolite in the exposed areas.

Cinnabar was found in 15 places in the bedrock exposed by trenching (figs. 5 through 9). Occurrences were small and erratic--generally as small lenses or as 1/4- to 1/2-inch wide, high-grade stringers, several feet or less in length. All were associated with silica-carbonate dikes and sills, occurring within them or at the contact with the sedimentary beds.

Occasionally, a few feet of the adjoining sedimentary rocks, if altered, were mineralized; where this occurred, cinnabar was in small erratic lenses and blebs. Sometimes there was very little alteration of the adjoining sedimentary beds by the silica-carbonate; if there was no alteration, there usually was no cinnabar in the silica-carbonate nor in the sedimentary rock. Mercury mineralization was not found in unaltered sedimentary beds, and only trace amounts were found in the rhyolite. A white, puttylike kaolin mineral (probably dickite) was often present in small amounts where cinnabar occurred, although it was not a positive indication of cinnabar as it sometimes occurred alone in the silica-carbonate. Only trace amounts of antimony and arsenic occur with the cinnabar; the only antimony found on the prospect was one small piece of float stibnite near the top of Juninggulra Mountain.

The strongest and topographically highest occurrence of mercury mineralization was found in trench 1 (figs. 4, 5, 10, and 11) at an altitude of approximately 670 feet. The lowest occurrence was at an altitude of 430 feet, in trench 17, in the southern end of the area investigated. In trench 1, cinnabar occurs in small lenses and stringers in a silica-carbonate sill 8 to 10 feet thick, dipping about 15° N., and lying on top of the upturned shale. This sill is near the shale-rhyolite contact and dips toward the rhyolite; it may contact the rhyolite. Minor amounts of cinnabar occurred in the adjoining shale but were confined to an altered zone only several feet wide. No mineralization was found at the contact between the bottom of the sill and the shale. The mineralized area exposed by trenching is about 140 by 20 feet, but its exact size is not known owing to excessive overburden on the steep hillside. An attempt to further outline the area with 2-inch auger holes (fig. 5) was not successful. Only a trace of cinnabar was found in one other silica-carbonate exposure in trench 1. An estimate made from channel samples taken in this 140- by 20-foot zone indicates a mercury content of about 2 pounds per ton.

A high-grade vein of cinnabar, 2 to 4 inches wide and 10 feet long, occurs in trench 7 (fig. 7) at the contact between a silica-carbonate sheet (or dike) and shale. The shale side of the contact was slickensided, showing postmineral movement. The strike of the vein was N. 70° W., and the dip was vertical; excavation indicated that it ended at the bottom of the silica-carbonate sill or at the shale contact, thus limiting the vertical depth of the vein to 6 to 7 feet.

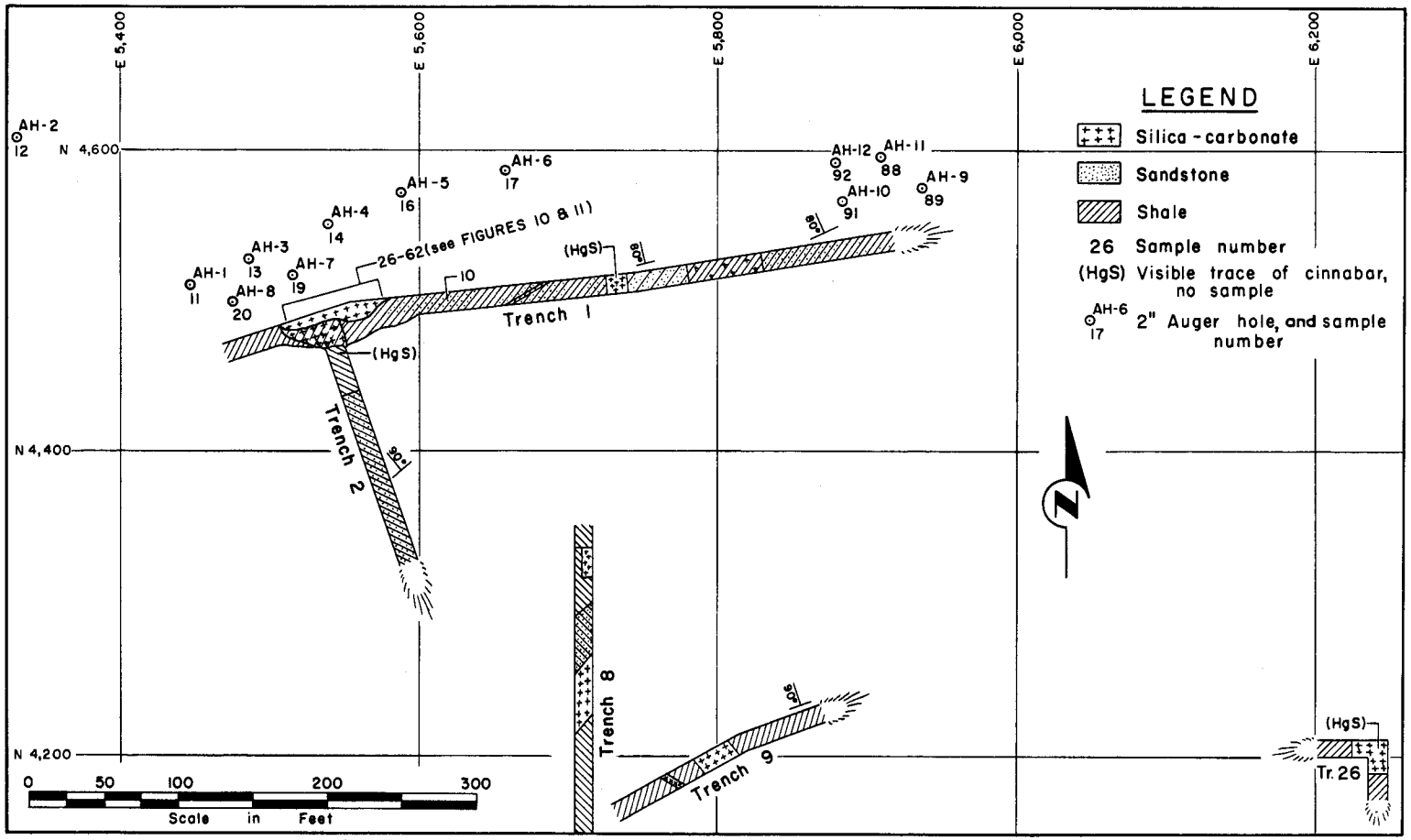

FIGURE 5. - Geologic Map of Trenches 1, 2, 8, and 9.

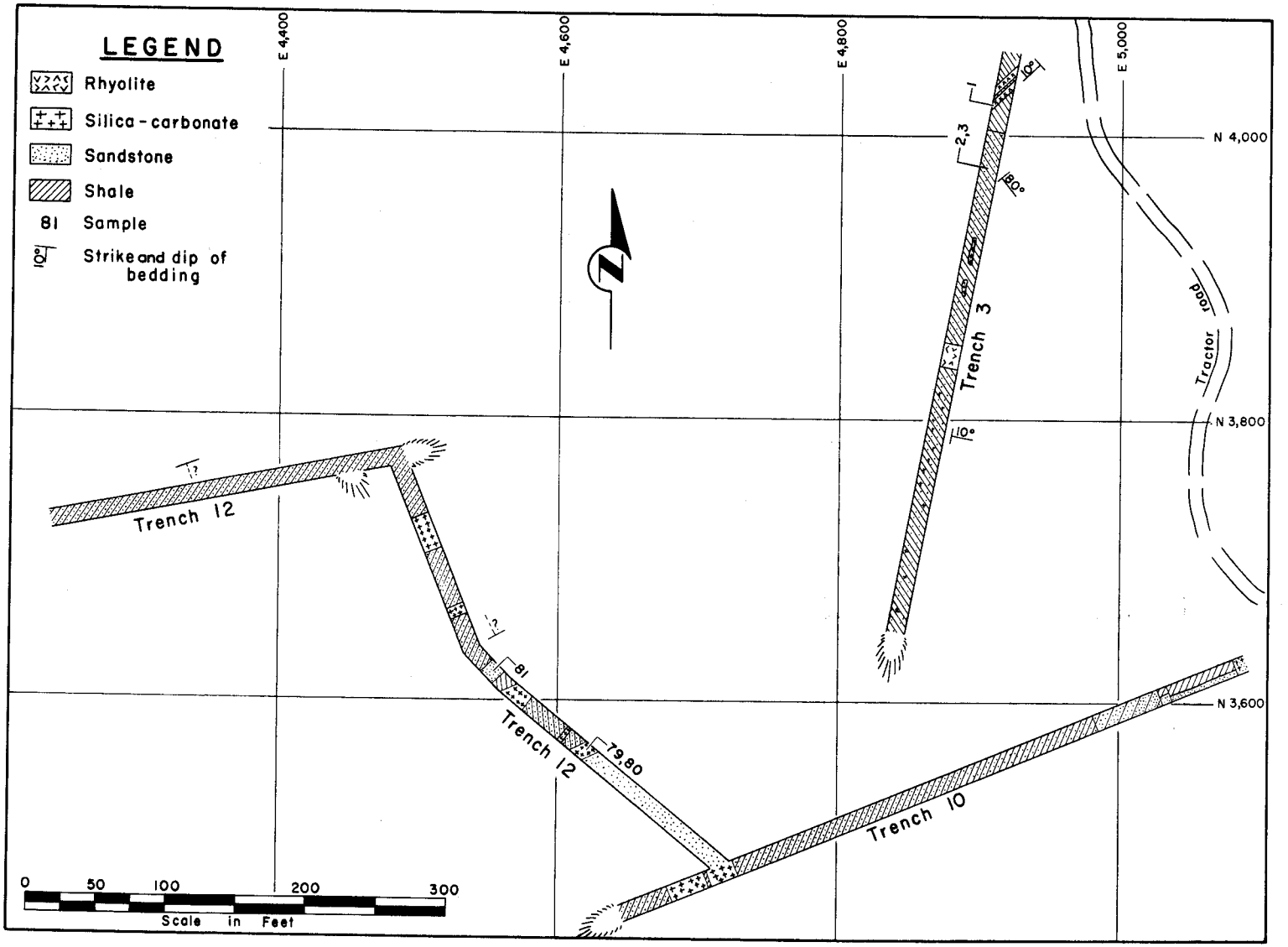

FIGURE 6. - Geologic Map of Trenches 3, 10, and 12.

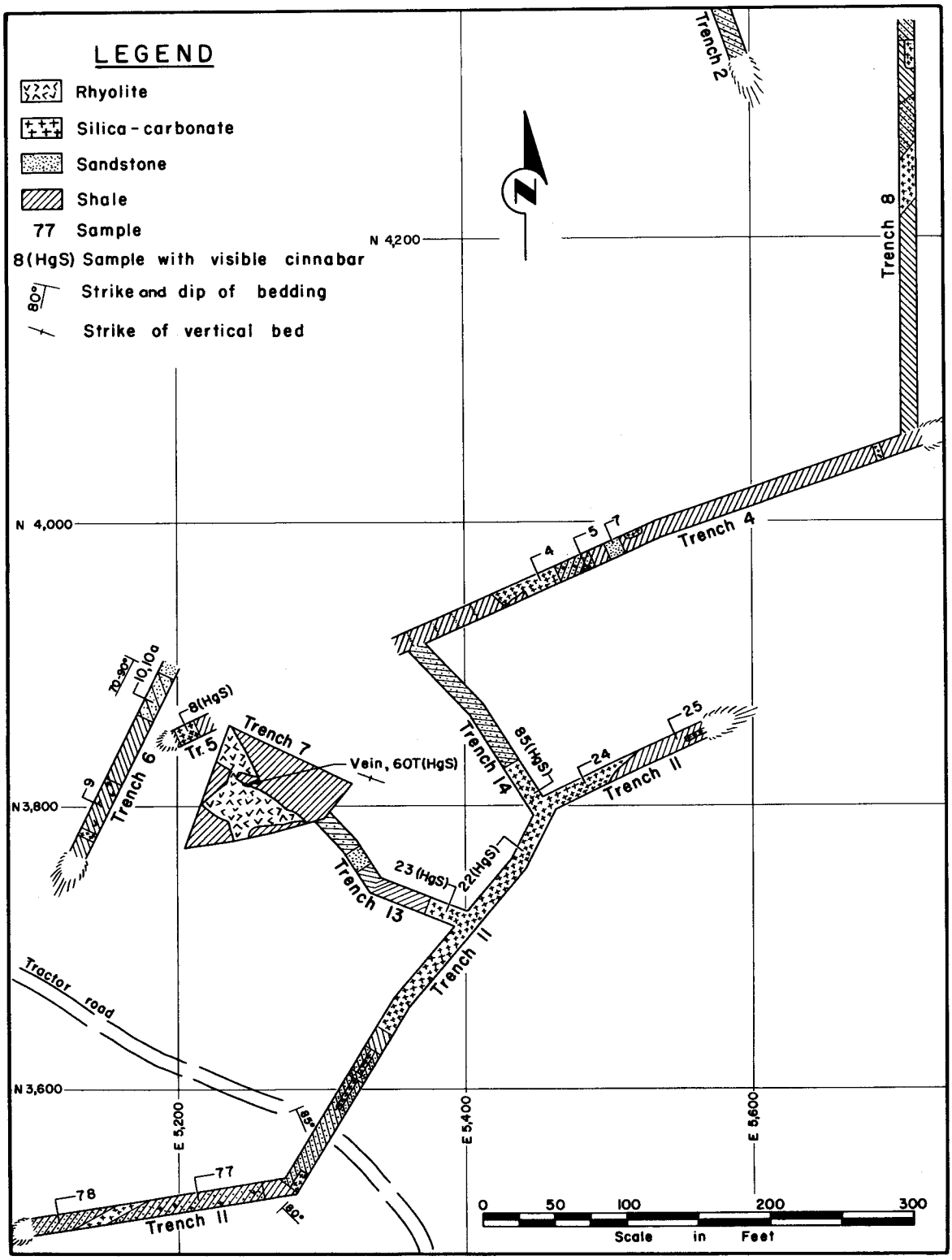

FIGURE 7. - Geologic Map of Trenches 4 to 8, 11, 13, and 14.

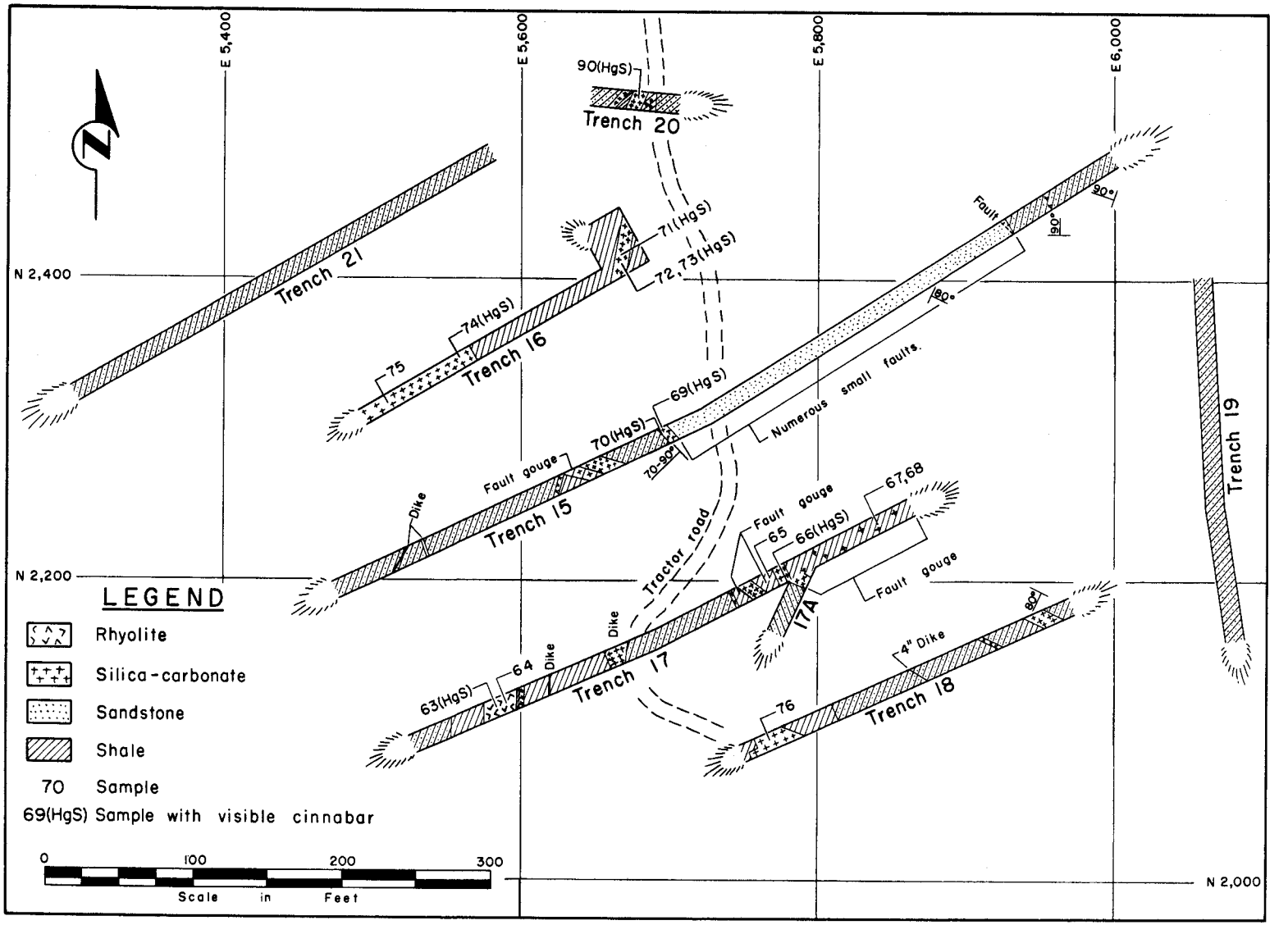

FIGURE 8. - Geologic Map of Trenches 15 to 21.

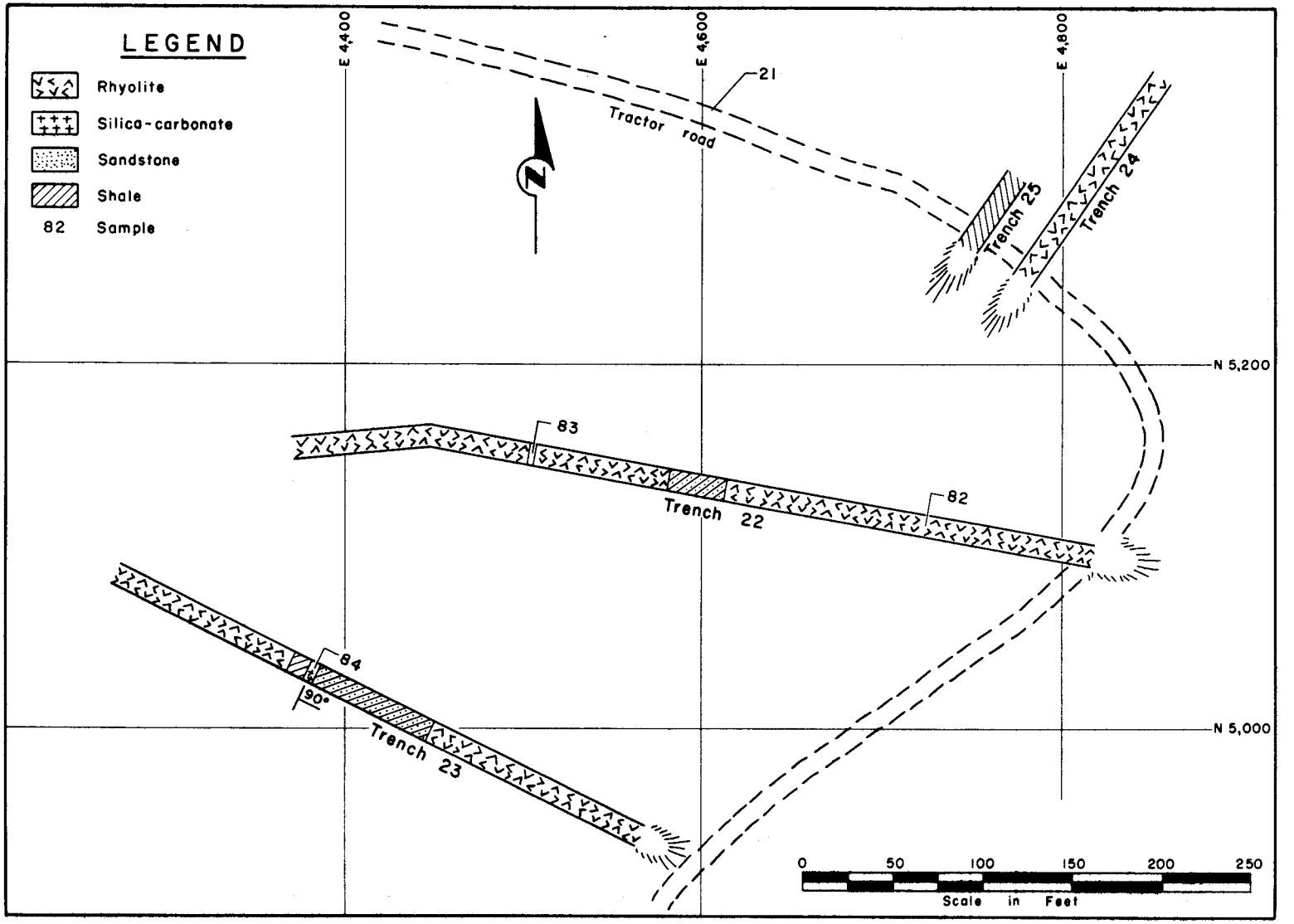

FIGURE 9. - Geologic Map of Trenches 22 to 25.

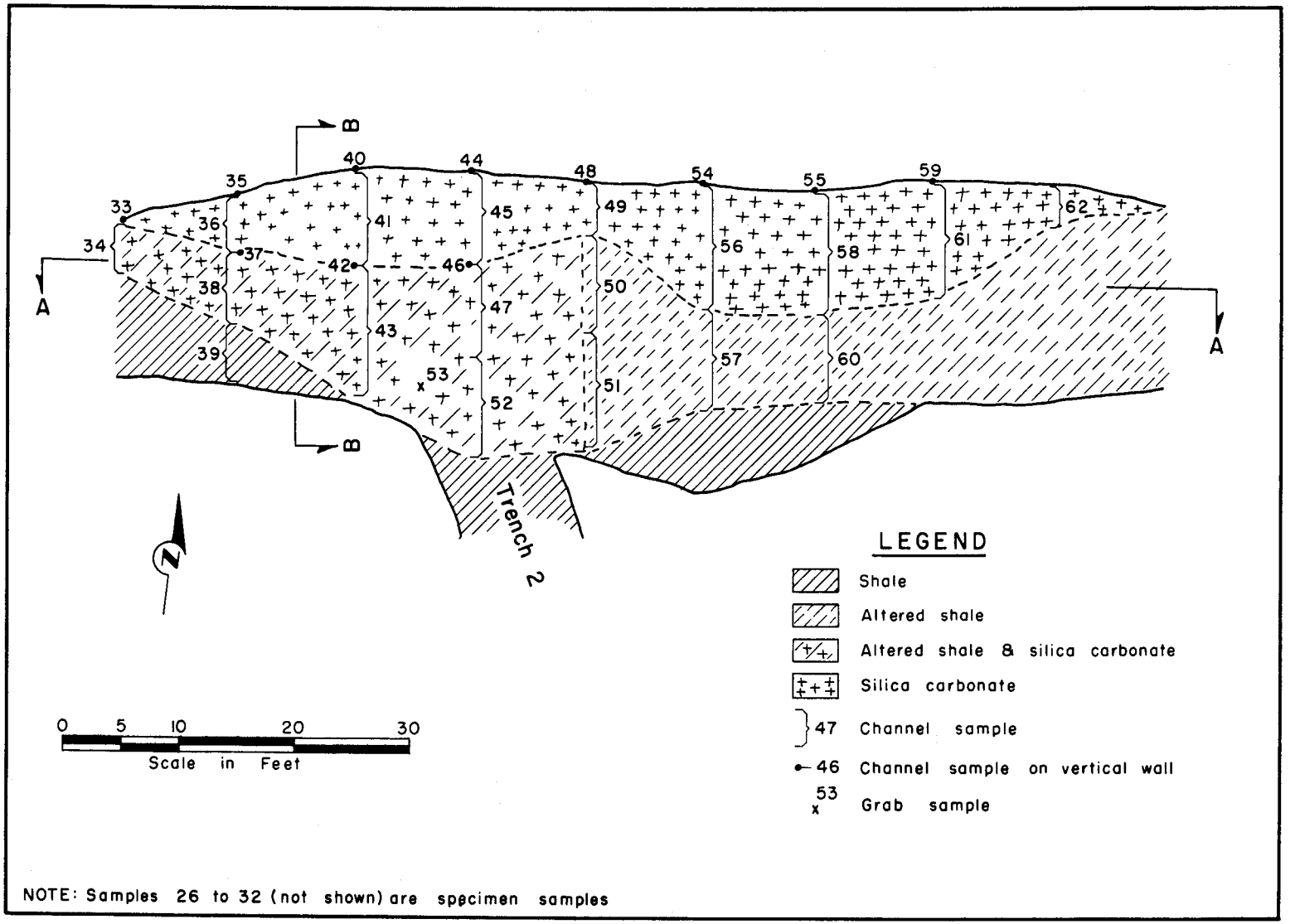

FIGURE 10. - Plan of Mineralized Area in Trench 1.

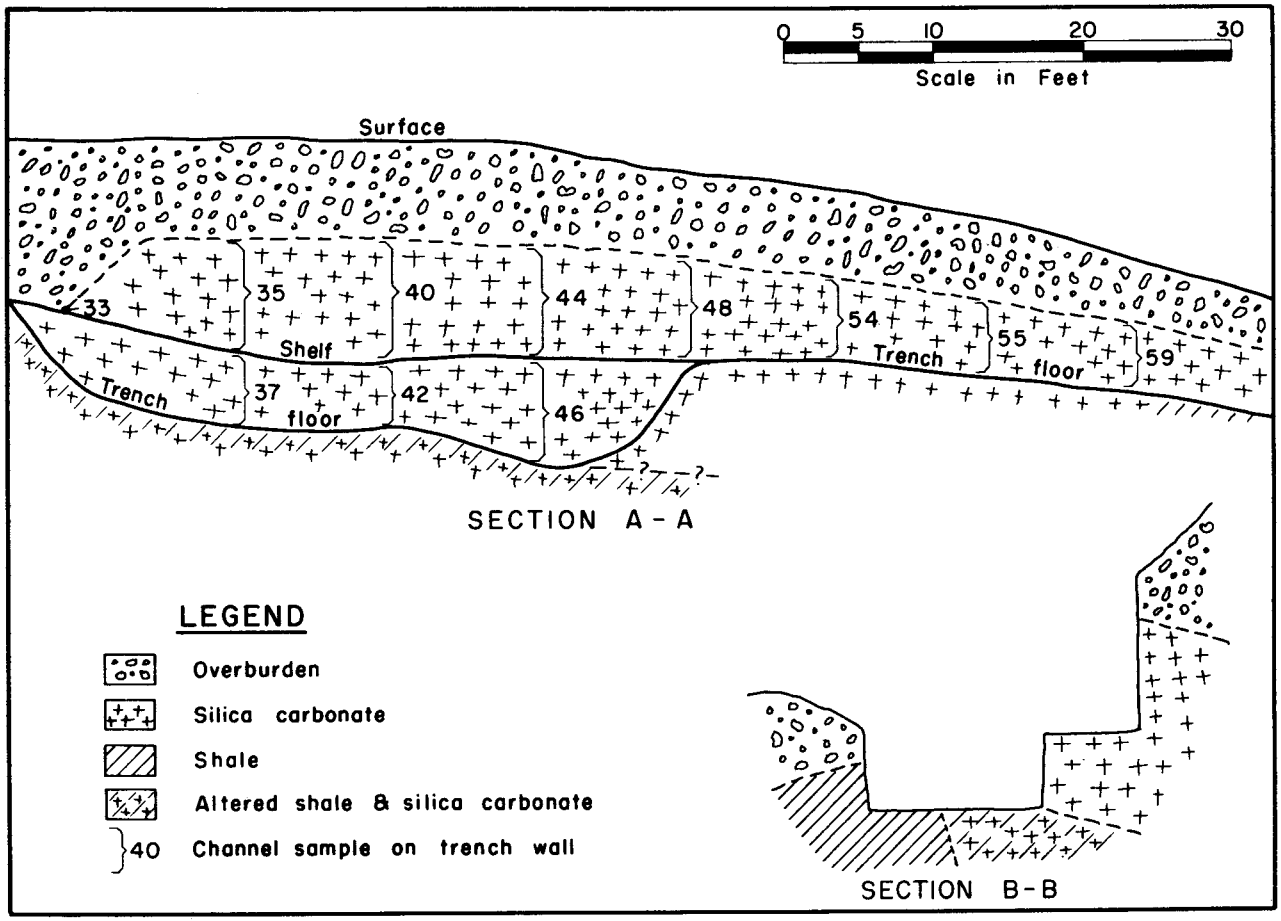

FIGURE 11. - Vertical Sections of Trench 1.

A silica-carbonate dike containing cinnabar was exposed in trench 17 (fig. 8), where, in an area about 4 to 6 feet, the mineral was erratically disseminated in small lenses and blebs. Mineralization was localized in this small area and had a depth of only a few feet.

The other occurrences were in small stringers and lenses; the best were in trench 16 (fig. 8); however, none were large, and most were only a single, short stringer of erratic mineralization.

The walls of the trenches were panned, and many show small to trace amounts of very fine cinnabar in particles one-sixteenth of an inch or less in diameter. A 12- by 12-inch piece of silica-carbonate float, containing considerable cinnabar, was found in trench 11; such float is very hard to detect during bulldozing operations and can be easily overlooked.

WORK BY THE BUREAU OF MINES

Twenty-six bulldozer trenches, 12.5 feet wide and totaling 7,326 linear feet, were excavated to bedrock. Ninety-two samples, mostly channel, were

taken, and twelve 2-inch auger holes, averaging about 12 feet in depth, were hand-drilled to bedrock. Two airstrips, necessary because of crosswinds, were leveled with the bulldozer; one was 1,000 feet long, and the other, 800 feet long.

Permafrost was encountered in all trenches, and in some places, continued to bedrock. The maximum depth of overburden and permafrost encountered was 16 feet; the average depth of both was about 10 feet. The trenches at the south end of the project averaged about 8 feet, and the permafrost, about 4 to 5 feet. Large ice lenses were often encountered a few feet below the surface, which added to the difficulties in trenching and particularly in moving the bulldozer.

Chemical, petrographic, and spectrographic analyses are in tables 1, 2, and 3, and the log of the trenches is in the appendix at the end of this report.

CONCLUSIONS

The geology of this virtually unprospected area is that usually associated with mercury mineralization in other parts of the Kuskokwim River Basin. Numerous dikes and sills, associated with a rhyolite intrusive and largely altered to silica-carbonate, were exposed by the bulldozer trenches. Some of the highly altered dikes and sills were mercury bearing; few, if any, had recognizable surface expression. The Rhyolite prospect occupies only a small segment on the periphery of the large Juninggulra Mountain intrusive, which, in turn, is only one of the several rhyolite intrusives in the area.

Permafrost makes trenching difficult and costly, because several trenches have to be started at the same time to facilitate thawing; hence, considerable work is done before any bedrock is exposed, and this often results in poor location of trenches. The use of portable augers, drills, or some other method of rapid subsurface reconnaissance would be desirable as an aid in placing bulldozer trenches in the most favorable locations.

TABLE 1. - Summary of trench sampling data

Sample	Trench	Interval or location, feet	Description	Analyses, percent		
				Hg	Sb	As
1	3	17 to 25	Type specimen of silica-carbonate sill.	<0.02	-	-
4	4	97 to 123	Type specimen of silica-carbonate intrusive.	.05	-	-
5	4	140 to 147	Type specimen of small basalt inclusions in sandstone.	< .02	-	-
8	5	2 to 17	Silica-carbonate with trace of cinnabar; sample is picked specimen of best mineralization.	.34	<0.05	0.01
99	6	18 to 57	Small inclusions of rhyolite in shale.	<.02	-	-
11	1	Hole 1	Auger hole in sandstone near west end trench 1.	<.02	-	-
12	1	Hole 2	Auger hole in shale near west end trench 1.	<.02	-	-
13	1	Hole 3	Auger hole in rhyolite near west end trench 1.	<.02	-	-
14	1	Hole 4	Auger hole in shale near west end trench 1.	<.02	-	-
16	1	Hole 5	Auger hole in sandstone near west end trench 1.	<.02	-	-
17	1	Hole 6	Auger hole in graywacke near west end trench 1.	<.02	-	-
19	1	Hole 7	Auger hole in sandstone near west end trench 1.	<.02	-	-
20	1	Hole 8	Auger hole in shale near west end trench 1.	<.02	-	-
21			Stibnite float near airstrip.	.08	66.3	<.05
22	11	520	Silica-carbonate with small amount of cinnabar.	.04	-	-
23	13	100 to 126	do.	<.02	-	-
24	11	522 to 552	Type specimen of silica-carbonate.	<.02	-	-
25	11	615 to 630	Type specimen of silica-carbonate dike.	<.02	-	-
26	1	60	Specimen of silica-carbonate sill and cinnabar.	1.70	<.05	.06
27	1	50	do.	.68	<.05	<.01
28	1	60	Specimen of altered shale and cinnabar.	.23	<.05	<.01
29	1	60	do.	.43	<.05	<.01
30	1	65	Specimen of silica-carbonate sill and cinnabar.	2.13	<.05	.01

TABLE 1. - Summary of trench sampling data (Con.)

Sample	Trench	Interval or location, feet	Description	Analyses, percent		
				Hg	Sb	As
31	1	70	Specimen of silica-carbonate sill and cinnabar.	0.10	-	-
32	1	70	do.	1.25	<0.05	0.02
33	1	37	Wall of silica-carbonate sill, 2 feet high.	.09	-	-
34	1	37	Wall of silica-carbonate sill, 4 feet high.	.09	-	-
35	1	47	Trench wall, 7 feet of silica-carbonate sill.	.08	-	-
36	1	47	4 feet of silica-carbonate sill.	.10	-	-
37	1	47	5-foot cross section of silica-carbonate sill.	.18	-	-
38	1	47	6 feet of sill and altered shale.	.14	-	-
39	1	47	5 feet of shale.	.10	-	-
40	1	57	Trench wall, 8 feet of silica-carbonate sill.	.21	-	-
41	1	57	8 feet of silica-carbonate sill.	.41	<.05	.01
42	1	57	4-foot cross section of silica-carbonate sill.	.40	<.05	.01
43	1	57	10 feet of sill and altered shale.	.45	<.05	.02
44	1	67	Trench wall, 7 feet of silica-carbonate.	.02	<.05	<.01
45	1	67	8 feet of silica-carbonate sill.	.05	-	-
46	1	67	7-foot cross section of silica-carbonate sill.	.21	-	-
47	1	67	4 feet of altered shale, minor amount of sill.	.09	-	-
48	1	77	Trench wall, 7 feet of silica-carbonate.	.03	-	-
49	1	77	5 feet of silica-carbonate sill.	<.02	-	-
50	1	77	8 feet of shale.	.07	-	-
51	1	77	10 feet of shale.	.04	-	-
52	1	67 to 77	Shale, grab sample.	.04	-	-
53	1	57 to 67	Shale, silica-carbonate, grab sample.	.13	-	-
54	1	87	Trench wall, 6 feet of silica-carbonate.	<.02	-	-

TABLE 1. - Summary of trench sampling data (Con.)

Sample	Trench	Interval or location, feet	Description	Analyses, percent		
				Hg	Sb	As
55	1	97	Trench wall, 5 feet of silica-carbonate.	<0.02	-	-
56	1	87	10 feet of silica-carbonate sill.	< .02	-	-
57	1	87	8 feet altered shale.	.02	-	-
58	1	97	10 feet of silica-carbonate sill.	.05	-	-
59	1	107	Trench wall, 4.5-foot silica-carbonate.	.10	-	-
60	1	97	6 feet, shale and silica-carbonate.	.15	-	-
60T	7	(See fig. 7)	High-grade vein cinnabar, 4 inches wide in trench 7.	54.0	<0.05	<0.01
61	1	107	10 feet silica-carbonate.	.02	-	-
62	1	117	4 feet silica-carbonate.	.06	-	-
63	17	52 to 76	Small piece of cinnabar in silica-carbonate dike.	1.49	< .05	< .01
64	17	52 to 76	Type specimen of above dike.	< .02	< .05	< .02
65	17	255 to 269	Type specimen of fault gouge.	.02	-	-
66	17	271 to 276	18-inch-wide zone of erratic cinnabar in silica-carbonate dike.	2.99	< .05	< .01
67	17	297 to 371	Type specimen of fault gouge in section containing gouge, shale, and silica-carbonate fragments.	< .02	-	-
69	15	350 to 357	Sample of 1/4-inch or less stringers of cinnabar, exposed in silica-carbonate sill.	3.75	< .05	< .01
70	15	356 to 357	Rusty-red, altered shale.	.27	-	-
71	16	71 to 73	Type specimen of best cinnabar in silica-carbonate dike.	3.98	< .05	< .01
72	16	71 to 73	Weathered brown portion of silica-carbonate dike.	.82	< .05	< .01
73	16	71 to 73	Light-gray, unaltered portion portion of above dike.	.71	< .05	< .01
74	16	134	Mineralized section, 4 to 6 inches wide and 2 feet long of silica-carbonate dike.	1.03	< .05	< .01
75	16	134 to 220	Type specimen of pink silica-carbonate.	.03	<.05	<.01
76	18	11 to 36	Type specimen of dolomite in silica-carbonate.	.02	-	-

TABLE 1. - Summary of trench sampling data (Con.)

Sample	Trench	Interval or location, feet	Description	Analyses, percent		
				Hg	Sb	As
77	11	0 to 43	Type specimen of shale and sandstone.	0.02	-	-
80	12	121 to 132	Silica-carbonate.	.04	-	-
82	22	0 to 208	Type specimen of rhyolite.	.03	-	-
83	22	316 to 319	Altered rhyolite.	.02	-	-
85	14	120 to 125	Erratic 1/4-inch stringers of cinnabar in silica-carbonate.	.07	-	-
88	1	Hole 11	Auger hole in sandstone near east end trench 1.	< .05	-	-
89	1	Hole 9	do.	.10	-	-
90	20	24 to 34	Silica-carbonate dike, small lenses cinnabar.	.69	< .05	< .01
91	1	Hole 10	Auger hole in sandstone near east end trench 1.	< .05	-	-
92	1	Hole 12	do.	< .05	-	-

TABLE 2. - Petrographic analyses

Sample	Trench	Interval, feet	Description
1	3	29 to 34	An epithermally altered rock, now composed of quartz with some hydromuscovite clay, and limonite. Some shale, composed of illite and chlorite with a trace of limonite, was present.
2	3	57 to 133	Altered tuffaceous sandstones, composed of illite and chlorite with small amounts of montmorillonite, limonite, quartz, and kaolin. The spectroscope indicates lithium.
3	3	57 to 133	Altered tuffaceous sandstone, composed of calcite, illite, chlorite, muscovite, traces of quartz, and limonite. The spectroscope indicates lithium.
4	4	97 to 123	Epithermally altered rock, now composed of hydromuscovite (illite clay of hydrothermal origin), chlorite, dolomite, and some fine quartz. Traces of magnetite, pyrite, and limonite stain are present.
5	4	123 to 150	Partly weathered basalt, containing some euhedral phenocrysts of augite. The groundmass has much limonite stain due to weathering. A trace of quartz is present.
7	4	162 to 173	Highly weathered felsite or tuff, containing euhedral biotite phenocrysts. The groundmass is albite.

TABLE 2. - Petrographic analyses (Con.)

Sample	Trench	Interval, feet	Description
8	5	2 to 17	Epithermally altered rock similar to a gossan by mineral composition. Composed of quartz, kaolin, limonite, chlorite, and a small amount of cinnabar. The white mineral coating is one of the kaolin minerals.
9	6	18 to 57	Altered porphyritic rhyolite, composed of hydromuscovite, quartz, and some biotite. Moderately small amounts of lithium.
10	6	107 to 141	Altered tuffaceous sandstone, composed of kaolin, illite, quartz, biotite-chlorite, and limonite stain. The spectroscope indicates lithium.
10a	6	107 to 141	Altered soda rhyolite, composed of quartz, albite, hydromuscovite, traces of muscovite, and limonite stain. Moderately small amounts of lithium.
11	1	Hole 1	Auger hole, 7 feet deep, near west end of trench 1. Altered tuffaceous sandstone containing some altered rhyolite and a small amount of shale; now composed of chlorite-biotite, illite, some quartz, kaolin, and limonite stain. Only a trace of montmorillonite may be present. The spectroscope indicates lithium.
12	1	Hole 2	Auger hole, 7 feet deep, near west end of trench 1. Phyllite with a trace of altered rhyolite, composed of hydrobiotite, hydromuscovite, chlorite, and some quartz. Kaolin and some montmorillonite is associated with sample.
13	1	Hole 3	Auger hole, 9 feet deep, near west end of trench 1. Altered porphyritic rhyolite, containing euhedral quartz phenocrysts, hydromuscovite, and chlorite but with less muscovite and albite; traces of epidote, hornblende, and kaolin are present.
14	1	Hole 4	Auger hole, 9 feet deep, near west end of trench 1. Shale composed of illite and chlorite.
16	1	Hole 5	Auger hole, 8.5 feet deep, near north side of trench 1. Altered, tuffaceous sandstone containing some altered rhyolite; composed of hydromuscovite, chlorite, and traces of quartz, limonite stain, and muscovite.
17	1	Hole 6	Auger hole, 8.5 feet deep, near north side of trench 1. Altered graywacke and altered rhyolite composed of hydromuscovite (illite), chlorite, quartz, and traces of muscovite.
19	1	Hole 7	Auger hole, 8.5 feet deep, near west end of trench 1. Altered, tuffaceous sandstone with some altered rhyolite and a small amount of shale. The chief minerals present are hydromuscovite (illite), chlorite, quartz, with less muscovite, montmorillonite, and a trace of limonite.

TABLE 2. - Petrographic analyses (Con.)

Sample	Trench	Interval, feet	Description
20	1	Hole 8	Auger hole, 8.5 feet deep, near west end of trench 1. Shale composed of illite and chlorite.
21			Float, 50 feet from top of ridge near airstrip. Composed of stibnite with cryptocrystalline quartz and stibiconite (hydrous antimony oxide). Quartz and limonite stain are present.
22	11	520	Epithermally altered rock or gossan, composed of quartz, cryptocrystalline quartz, kaolin, chlorite, and a small amount of oligoclase and limonite stain. Lithium is present in trace amounts.
23	13	100 to 126	Epithermally altered rock or gossan, composed of cryptocrystalline quartz with some kaolin, hydromuscovite, limonite, and a trace of quartz. The white veins are mixtures of kaolin, cryptocrystalline quartz, and quartz. Cinnabar is present.
30	1	37 to 107	Epithermally altered igneous rock, now composed of cryptocrystalline quartz, quartz, kaolin, and limonite. Cinnabar and a trace of chromite in octahedral form are present. The soft white areas are kaolin. The presence of octahedrons of chromite indicate that the rock may have been derived from an ultrabasic.
36	1	37 to 107	Epithermally altered igneous rock, composed of cryptocrystalline quartz, kaolin, limonite, and quartz. Traces of chlorite, chromite, and cinnabar are present. As noted in log of trench 1, part of bedrock was shale. Part of sample 36 is an epithermally altered shale, now composed of illite (hydromuscovite) cryptocrystalline to fine quartz, kaolin, limonite, and ankerite. Traces of cinnabar are present. There is a trace of a green claylike material; the color is due to the presence of chromium oxide.
39	1	37 to 107	Altered shale, composed of hydromuscovite and hydrobiotite with limonite, quartz, kaolin, and a minor amount of chlorite. A trace of cinnabar associated with kaolin is present.
52	1	37 to 107	Altered sandy shale and shale, composed of hydromuscovite, kaolin, quartz, some limonite, and chlorite. A trace of hornblende and muscovite are present.
53	1	37 to 107	Epithermally altered rock, now composed of quartz, kaolin, limonite, and traces of hydromuscovite and cinnabar. Inclusions of argillite composed of illite (hydromuscovite) with some chlorite and limonite. No carbonaceous material.

TABLE 2. - Petrographic analyses (Con.)

Sample	Trench	Interval, feet	Description
60	1	37 to 107	Epithermally altered rock, now composed of quartz, kaolin, limonite, and traces of hydromuscovite and cinnabar. Inclusions of argillite composed of illite (hydromuscovite) with some chlorite and limonite. No carbonaceous material.
63	17	52 to 76	Epithermally altered rock, now composed of quartz, kaolin, some limonite and cinnabar, and traces of chlorite, oligoclase, and chromite.
64	17	52 to 76	Epithermally altered rock, now composed of quartz with kaolin, hydromuscovite, limonite stain, and a small amount of chromite. Quartz phenocrysts are present.
65	17	255 to 269	Shale, composed of illite and hydrobiotite with some chlorite, and a trace of cryptocrystalline quartz.
66	17	269 to 277	Epithermally altered rock, now composed of quartz, kaolin, limonite, cinnabar, and traces of chlorite and biotite.
67	17	297 to 371	Chiefly a carbonaceous shale, composed of illite, chlorite, and carbonaceous material. The dark-gray to black color is not due to manganese. A small amount of epithermally altered rock, now composed of quartz, kaolin, and limonite, is present.
68	17	297 to 371	Epithermally altered rock, now composed of kaolin, ankerite, quartz, some dolomite, limonite stain, and a trace of cinnabar.
69	15	350 to 356	Epithermally altered rock, now composed of kaolin, small amounts of quartz, limonite, chlorite, cinnabar, and a trace of chromite.
70	15	356 to 357	Epithermally altered rock, now composed of cryptocrystalline quartz with kaolin, small amount of chlorite, limonite, and a trace of cinnabar and chromite.
71	16	12 to 26	Epithermally altered rock, now composed of kaolin, cryptocrystalline quartz, some limonite, chlorite, cinnabar, and traces of quartz, biotite, illite, and chromite. Phenocrysts of quartz, altered in part to cryptocrystalline quartz are present.
72	16	12 to 36	Epithermally altered rock, now composed of kaolin, cryptocrystalline quartz, quartz, limonite, small amount of chromite, and traces of cinnabar and chlorite.
73	16	12 to 26	Epithermally altered rock, now composed of cryptocrystalline quartz, kaolin, chlorite with quartz, chromite, and a trace of cinnabar and limonite. Quartz phenocrysts are present.

TABLE 2. - Petrographic analyses (Con.)

Sample	Trench	Interval, feet	Description
74	16	130 to 132	Epithermally altered rock, now composed of quartz, kaolin, cryptocrystalline quartz, limonite, a small amount of a yellow titanium mineral, which may be anatase, and traces of cinnabar, hornblende, pyrite, and chlorite.
75	16	130 to 220	Epithermally altered rock, now composed of cryptocrystalline quartz, kaolin, ankerite, quartz, dolomite, and traces of chromite, chlorite, and limonite. No cinnabar. Quartz phenocrysts are present. This rock has a pink color.
76	18	11 to 36	Weathered, brown silica-carbonate limonite.
77	11	85 to 163	Two different materials. Altered tuffaceous sandstone composed of hydrobiotite, chlorite, and hydromuscovite with quartz, albite, oligoclase, muscovite, kaolin, and limonite stain. Silica-carbonate, composed of ankerite, cryptocrystalline quartz, kaolin, and quartz with limonite, chlorite, and hydromuscovite.
78	11	0 to 43	Altered tuffaceous sandstone, composed of kaolin, fine quartz with less chlorite, hydromuscovite, limonite, and a trace of biotite.
79	12	0 to 121	Altered tuffaceous sandstone, composed of quartz, chlorite, some hydromuscovite, and traces of albite and limonite.
80	12	121 to 132	Silica-carbonate, composed of oligoclase with some cryptocrystalline quartz and limonite stain, and traces of biotite, chromite, and chlorite.
81	12	206 to 218	Altered tuffaceous sandstone, composed of chlorite, hydromuscovite, some kaolin and muscovite, and a trace of quartz.
82	22	0 to 208	Sample was intended as a type specimen of rhyolite; however, some material from a clay slip in this interval may have gotten into sample. Two different types of material: (1) A greisen, composed chiefly of a lithium mica, tentatively identified as lepidolite (some quartz and kaolin); (2) an altered rhyolite, composed of hydromuscovite (illite) and quartz. Some green muscovite, kaolin, chlorite, and limonite stain. Trace (normal) of lithium.
83	22	316 to 319	Two different materials in sample: (1) An altered rhyolite composed of quartz, albite, hydromuscovite with green muscovite, traces of kaolin, chlorite, and cinnabar (spectroscope indicates lithium); (2) an altered felsite composed of hydromuscovite, quartz, kaolin, and traces of chlorite and cinnabar.

TABLE 2. - Petrographic analyses (Con.)

Sample	Trench	Interval, feet	Description
84	23	119 to 125	Epithermally altered rock, composed of quartz, kaolin, and limonite.
85	14	120 to 125	Epithermally altered rock, composed of cryptocrystalline quartz, limonite, kaolin, and a trace of cinnabar.
88	1	Hole 11	Auger hole, 6 feet deep, near east end of trench 1. Altered rhyolite, composed of hydromuscovite (illite), chlorite, quartz, traces of limonite stain and montmorillonite clay. Spectroscope indicates lithium.
89	1	Hole 9	Auger hole, 5.5 feet deep, near east end of trench 1. Altered rhyolite and tuffaceous sandstone, composed of hydromuscovite, chlorite, quartz with traces of muscovite, limonite stain, montmorillonite, potash feldspar, hornblende, and a trace of lithium.
90	20	24 to 34	Epithermally altered rock, composed of quartz kaolin, limonite, and cinnabar.
91	1	Hole 10	Auger hole, 6.3 feet deep, near east end of trench 1. Tuffaceous sandstone containing a trace of rhyolite, composed of hydromuscovite, chlorite, quartz, small amount of kaolin, and traces of limonite stain and montmorillonite.
92	1	Hole 12	Auger hole, 4.3 feet deep, near east end of trench 1. Altered rhyolite composed of hydromuscovite, chlorite, and quartz with traces of muscovite, kaolin, hornblende, limonite stain, calcite, montmorillonite, and lithium.

TABLE 3. - Spectrographic analyses

Legend

A over 10 percent.
B 5 to 10 percent.
C 1 to 5 percent.
D 0.1 to 1 percent.
E 0.01 to 0.1 percent.
F 0.001 to 0.01 percent.
G under 0.001 percent.
- not detected.

Element	Sample		Type specimen, trench 1		
	3	82	Silica-carbonate and cinnabar	Silica-carbonate, shale, and cinnabar	Altered shale
Al	A	A	C	C	C
B	E	D	F	E	E
Ba	E	D	D	D	D
Be	G	G	G	G	-
Ca	A	E	E	F	D
Co	-	-	F	F	F
Cr	F	F	E	E	E
Cu	F	F	F	F	F
Fe	A	A	C	C	C
Ga	G	G	-	-	-
Hg	-	-	D	A	E
Mg	C	D	D	E	D
Mn	D	E	E	F	E
Mo	-	-	F	E	E
Na	E	C	-	-	E
Ni	F	F	E	E	D
Pb	E	E	-	-	-
Sb	-	-	-	-	E
Si	A	A	A	A	A
Sr	-	-	E	D	D
Ti	C	D	D	D	D
V	E	-	E	E	E
Zr	-	-	F	F	F
Y	F	-	-	-	-

Note: Checking took place for elements Ag, As, Au, Bi, Cd, Ge, Hf, In, Li, Nb, P, Pd, Pt, Rh, Sn, Ta, Te, Tl, W, and Zn; however, these elements were not detected.

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APPENDIX. - LOGS OF TRENCHES

Trench 1

Length: 455 feet.
Bearing: 0 to 89 feet, N. 72° E.
89 to 300 feet, N. 84° E.
300 to 455 feet, N. 81° E.

Average depth: 10 feet.
Maximum depth: 16 feet.
"0" is west end.
This trench is probably within 100 feet of rhyolite-shale contact.

Interval, feet	Sample		Description
	Petrographic	Chemical	
0 to 37	-	-	Shattered shale.
37 to 107	30, 36 39, 52, 53, 60	26, 62	The largest area of cinnabar mineralization found. When first exposed, the bedrock was silica-carbonate with erratic dissemination of cinnabar. Additional excavation removed the silica-carbonate and exposed the unmineralized slate bedrock underneath. Apparently the silica-carbonate is a flat-lying 8- to 9-foot-thick sill. Contacts at 37 and 107 feet are N. 30° E.
107 to 189	-	-	Shattered silicified shale and light-gray silicified sandstone.
189 to 205	-	-	Shattered shale and compact sandstone. Limonite stain on fractures. Small amount of white kaolin.
205 to 209	-	-	18 inches of very soft, black shale or fault gouge; strike N. 60° E.
209 to 260	-	-	Dark-gray shale and poorly cemented sandstone. At 254 feet, beds strike N. 70° E. and dip 80° N.
260 to 273	-	-	Weathered, brown silica-carbonate sill with 10° dip S. Considerable silica-carbonate float in lower 4 feet of north wall of the trench. Minor alteration of shale at contact. Trace of cinnabar in silica-carbonate.
273 to 315	-	-	Thin-bedded shales and sandstone. Excellent exposure of attitude of beds at 280 to 300 feet; strike is N. 75° E. and dip 80° N.
315 to 365	-	-	Altered shale, shale, soft to medium hard sandstone, considerable weathered silica-carbonate, and chert. Trace of cinnabar in silica-carbonate. This appears to be the south edge of a sill that extends northward.
365 to 455	-	-	Shale and soft sandstone. At 400 feet, excellent exposure of strike (N. 65° E.) and dip (80° N.) of beds. At 405 to 455 feet, no permafrost after 12-foot depth. In rest of trench permafrost was still present at 16-foot maximum depth.

Trench 2

Length: 150 feet.
Bearing: S. 20° E.

Average depth: 8.5 feet.
Maximum depth: 13 feet.
"0" is north end.

Interval, feet	Description
0 to 33	Altered shale and minor amount of cinnabar, which is very erratic.
33 to 150	Shale, sandy shale, soft sandstone, strike of bedding N. 50° E., vertical dip. Walls of trench panned no cinnabar.

Trench 3

Length: 417 feet.
Bearing: S. 11° W.

Average depth: 10.5 feet.
Maximum depth: 14.0 feet.
"0" is north end.

Interval, feet	Sample		Description
	Petrographic	Chemical	
0 to 17	-	-	Shale.
17 to 25	-	-	Light-brown, weathered silica-carbonate, fractured with thin coating of light cream-colored kaolin on fractures. Minor amount of limonite stain and a few 1/4-inch calcite stringers. Contact at 25 feet strikes N. 48° E. This appears to be a 2- to 3-foot sill with a 10° dip SW.
25 to 29	-	-	Chill zone of altered shale and some weathered silica-carbonate.
29 to 34	1	1	Mostly weathered silica-carbonate and some shale.
34 to 57	-	-	Dark-gray broken shale and occasional thin layers of sandstone.
57 to 133	2, 3	-	Broken, shattered dark-gray shale with numerous thin layers of light-brown to light-gray sandstone, probably derived from weathered graywacke. Bedding strikes N. 50° E. and dips 80° SE. Samples 2 and 3 are of sandstone.
133 to 152	-	-	Dark-gray shale, sandy shale, and sandstone with a 2-foot-wide lens of weathered silica-carbonate down center of trench. A 1-foot-wide halo of altered shale surrounds this lens.
152 to 163	-	-	Shale.
163 to 174	-	-	Shale with a 2-foot, irregular-shaped lens of silica-carbonate which strikes N. 10° E.

Trench 3 (Con.)

Interval, feet	Sample		Description
	Petrographic	Chemical	
174 to 209	-	-	Shale and occasional bands of sandstone.
209 to 226	-	-	Light-green, altered rhyolite.
226 to 318	-	-	Altered shale, sandstone, and weathered silica-carbonate. Kaolin on fractures of silica-carbonate which appears to be part of a sill, dipping 10° E.
318 to 417	-	-	Shale, sandstone, and small stringers of silica-carbonate.

Trench 4

Length: 394 feet.
Bearing: 0 to 200 feet, N. 66° E.
200 to 394 feet, N. 71° E.

Average depth: 7.5 feet.
Maximum depth: 11.5 feet.
"0" is southwest end.

Interval, feet	Sample		Description
	Petrographic	Chemical	
0 to 67.5	-	-	Dark-gray shale, sandy shale, and small lens of sandstone.
67.5 to 78	-	-	Altered shale.
78 to 97	-	-	Weathered, brown silica-carbonate; bearing of contact at 78 feet is N. 47° W.; no faulting. On north wall of trench silica-carbonate extends 4 feet up wall of trench. At base of south wall the bedrock is shale. The contact between shale and silica-carbonate is approximately in center of trench.
97 to 123	4	-	Weathered, brown silica-carbonate, which is light-gray where not weathered. Not as weathered as 78- to 97-foot section.
123 to 150	5	5	Very hard shale, sandstone which is almost a quartzite, and occasional small inclusions of silica-carbonate; from 140 to 147 feet, weathered silica-carbonate protrudes out 4 feet from south wall of trench (sample 5).
150 to 162	-	-	Hard, altered shale; considerable limonite stain.
162 to 173	7	-	Either a soft sandstone, derived directly from an igneous material, or a tuff.
173 to 200	-	-	Hard, altered shale; considerable limonite stain. From 178 to 191 feet, a lens of weathered silica-carbonate extends 5 feet in an irregular line toward the center of the trench from the north wall. It is not present in the

Trench 4 (Con.)

Interval, feet	Sample		Description
	Petrographic	Chemical	
173 to 200 (Con.)			south wall. The lens starts at the bottom of the trench at 178 feet on the north wall and is 3 feet high on the wall at 191 feet.
200 to 360	-	-	Black shale and minor amount of sandstone.
360 to 365			Irregular lens of weathered silica-carbonate, striking about normal to trench and not exposed in south wall.
365 to 394	-	-	Shale and soft sandstone.

Trench 5

Length: 29 feet.
Bearing: N. 64° E.

Average depth: 7.0 feet.
Maximum depth: 11.0 feet.
"0" is south end.

Interval, feet	Sample		Description
	Petrographic	Chemical	
0 to 2			Altered, black shale.
2 to 17	8	8	Weathered, brown silica-carbonate and trace of cinnabar which is usually associated with cream-colored kaolin. Strike of contact N. 25° W.
17 to 29	-	-	Altered shale.

Trench 6

Length: 149 feet
Bearing: N. 26° E.

Average depth: 7.0 feet.
Maximum depth: 11.0 feet.
"0" is south end.

Interval, feet	Sample		Description
	Petrographic	Chemical	
0 to 12	-	-	Shale.
12 to 18	-	-	Weathered, brown silica-carbonate; strike normal to trench. Walls of trench from 6 to 14 feet panned minor amount of coarse cinnabar.
18 to 57	9	9	Shale and occasional 12-inch inclusions of rhyolite. Sample 9 is of rhyolite.
57 to 107			Shale and sandy shale.
107 to 141	10, 10a		75 percent medium-grained, thin-bedded sandstone and shale. Strike of beds is normal to trench and dip 80° S. 25 percent altered rhyolite. Sample 10 is of sandstone, and sample 10a is of rhyolite.
141 to 149	-	-	Soft sandstone; considerable folding of beds.

Trench 7

Length: 200 by 200 feet.

Average depth: 8 feet.
Maximum depth: 14 feet.

Interval, feet	Description
-	This is where an area about 200 by 200 feet was excavated to bedrock (fig. 7). A high-grade vein of cinnabar, about 2 to 6 inches wide, had been exposed by previous trenching. A fairly flat silica-carbonate sill, about 10 feet thick, intrudes the shale. The cinnabar vein could only be followed for a few feet and was on the contact between the sill and shale. There is evidence of post mineral movement.

Trench 8

Length: 287 feet.
Bearing: N. and S.

Average depth: 8.0 feet.
Maximum depth: 11.0 feet.
"0" is south end of trench and is the junction of trench 4 and trench 8. Overburden is fine silt and rhyolite fragments, found to within 3 feet of the trench bottom.

Interval, feet	Description
0 to 157	Dark-gray, shattered shale.
157 to 197	Weathered, brown silica-carbonate; strike of contacts N. 40° E.
197 to 233	Black, altered shale and very hard brown sandstone; some limonite stain.
233 to 235	Irregular-shaped lens of weathered silica-carbonate strike N. 50° W.
235 to 257	Shale.
257 to 276	Brown, weathered silica-carbonate, extending 8.5 feet from the east side of the trench. The remaining 4.5 feet of the 13-foot-wide trench is highly altered shale.
276 to 287	Shale and sandstone; the walls in this section of the trench pan minor amounts of fairly coarse cinnabar from bedrock to the surface.

Trench 9

Length: 155 feet.
Bearing: 0 to 100 feet, N. 61° E.
100 to 155 feet, N. 70° E.

Average depth: 9.0 feet.
Maximum depth: 11.0 feet.
"0" is southwest end.
Permafrost to bottom of entire trench.

Interval, feet	Description
0 to 41	Black, fractured shale and lighter colored soft sandstone. General character of overburden of trench is fine sandy silt.
41 to 46	Weathered, brown silica-carbonate, about 3 feet wide and striking S. 60° E. On northwest side of trench it is exposed only in the bottom of trench, whereas on northeast side it is exposed for 2 feet in the wall. Minor chill zone at contacts.
46 to 64	Broken shale and sandstone.
64 to 90	Silica-carbonate; contacts N. 40° W.; alteration at contact is minor. Upper 4 feet of overburden pans minor amount of fairly coarse cinnabar.
90 to 155	Shale and sandstone; bedding strikes N. 70° E. and dip is vertical.

Trench 10

Length: 480 feet.
Bearing: S. 68° W.

Average depth: 9.0 feet.
Maximum depth: 11.5 feet.
"0" is northeast end. Overburden of trench fairly coarse material mostly shale and sandstone.
Permafrost to bottom of entire trench.

Interval, feet	Description
0 to 8	Weathered, brown sandstone and silica-carbonate. Considerable alteration of sandstone.
8 to 59	Shattered, black shale, extending 7 feet from north wall, and weathered, brown sandstone in remaining part along south wall.
59 to 66	Weathered, brown sandstone and shale.
66 to 115	Altered shale, soft sandstone, and minor amount of sandstone that is almost a quartzite.
115 to 200	Much shattered shale and sandstone extends 3 to 4 feet up the northwest wall and is in place. The entire southeast wall is silt. The bottom of the trench is bedrock.
200 to 391	Shale, sandstone, and sandy shale.
391 to 442	Weathered, brown silica-carbonate with 2 feet of shale at 412 to 414 feet.
442 to 480	Shale and sandstone.

Trench 11

Length: 630 feet.
Bearing: 0 to 182 feet, N. 81° E.
182 to 332 feet, N. 31° E.
332 to 460 feet, N. 40° E.
460 to 510 feet, N. 27° E.
510 to 568 feet, N. 64° E.
568 to 630 feet, N. 66° E.

Average depth: 7.0 feet.
Maximum depth: 8.5 feet.
"0" is west end.

Interval, feet	Sample		Description
	Petrographic	Chemical	
0 to 43	78	78	Hard, gray sandstone and blocky and shattered shale. Strike of bedding is N. 31° E.
43 to 63	-	-	Weathered, brown silica-carbonate sill; strike S. 60° W., and dip is steep to the south.
63 to 85	-	-	Shale, hard sandstone; bedding strikes S. 60° W., and dips 70° S.
85 to 163	77	-	Shale, very hard, thin bands of sandstone, and minor amounts of silica-carbonate.
163 to 182	-	-	Shale and sandstone; strike of bedding S. 45° W. and dip 80° S. Considerable deformation.
182 to 196	-	-	North half of trench is black, thin-bedded shales and sandstones; strike of bedding is N. 68° E. and dip is vertical. South half of trench is partially weathered silica-carbonate, which is light gray when not weathered. At 196 feet, silica-carbonate curves into south wall. Contact between sediments and silica-carbonate is along bedding plane of shale.
196 to 247	-	-	Thin-bedded, black shales and sandstone; much of sandstone is very hard. Strike of bedding N. 65° E. and dip is vertical or slightly to the south.
247 to 272	-	-	Lens of brown, weathered silica-carbonate, about 3 feet wide in center of trench; from 65 to 74 feet, it extends into north wall of trench; 18- to 24-inch silicified zone of hard shale on both sides.
272 to 276	-	-	Altered shale and sandstone.
276 to 295	-	-	Weathered, brown silica-carbonate.
295 to 299	-	-	Highly altered shale; silicified zone.
299 to 311	-	-	Black shale.
311 to 522	22	22	Weathered, broken, brown silica-carbonate; center of rock fragments often are unweathered and light gray. Considerable cream-colored kaolin present. One 1- by 4-inch

Trench 11 (Con.)

Interval, feet	Sample		Description
	Petrographic	Chemical	
311 to 522 (Con.)			piece of very high-grade, well-worn cinnabar float. Small amount of cinnabar at 520 feet. Several prospect holes a few feet north of this section carried fairly good cinnabar float. From 347 to 382 feet, walls of trench panned fair amount of cinnabar.
522 to 552	-	24	Same as 311 to 522 feet but not as much weathered; some is light gray and some is limonite stained. Walls pan appreciable amount of coarse cinnabar.
552 to 582	-	-	Predominately shale and minor silica-carbonate. Most of south side of trench is shale.
582 to 614	-	-	Shale.
614 to 630	-	25	Shale with 4-foot-wide zone of weathered, brown silica-carbonate down center of trench. Sample 25 is of silica-carbonate.

Trench 12

Length: 633 feet.
Bearing: 0 to 200 feet, N. 51° W.
200 to 235 feet, N. 44° W.
235 to 382 feet, N. 22° W.
382 to 633 feet, S. 79° W.

Average depth: 8.0 feet.
Maximum depth: 12.0 feet.
"0" is south end and at junction with trench 10. Permafrost to bottom and large ice lens in overburden.

Interval, feet	Sample		Description
	Petrographic	Chemical	
0 to 121	79	-	Hard sandstone and some shale.
121 to 132	80	80	Weathered, brown silica-carbonate; contact strikes S. 64° W.; no chill zone.
132 to 143	-	-	Shale and sandstone.
143 to 147	-	-	Irregular lens of silica-carbonate, partially surrounded by clay.
147 to 179	-	-	Dark-gray shale and sandstone; small 1-inch wide irregular lens of silica-carbonate at 164 feet.
179 to 197	-	-	Weathered, brown silica-carbonate; irregular contact at 179 feet and minor chill zone; contact at 197 feet is sharp with a 6-inch clay seam; strike is S. 65° W.
197 to 206	-	-	Shale.
206 to 218	81	-	Tuffaceous sandstone.
218 to 260	-	-	Thin-bedded shale, sandstone, and clay; strike of bedding S. 60° W.

Trench 12 (Con.)

Interval, feet	Sample		Description
	Petrographic	Chemical	
260 to 382	-	-	Shale, sandstone, and silica-carbonate partially exposed; some frozen muck and large ice lenses. Silica-carbonate between 260 to 268 feet and 310 to 335 feet.
382 to 633	-	-	Shale, sandstone, and sandy shale. General strike of bedding N. 70° to 75° E.

Trench 13

Length: 126 feet.
Bearing: 0 to 27 feet, S. 43° E.
27 to 60 feet, S. 33° E.
60 to 126 feet, S. 68° E.

Average depth: 9.0 feet.
Maximum depth: 10.0 feet.
"0" is northwest end.

Interval, feet	Sample		Description
	Petrographic	Chemical	
0 to 32	-	-	Mostly shale and some sandstone.
32 to 46	-	-	Light-brown, medium-grained sandstone.
46 to 100	-	-	Shale, some sandstone, and clay.
100 to 126	23	23	Weathered, brown silica-carbonate and small amount of cinnabar. Contact at 100 feet is irregular.

Trench 14

Length: 123 feet.
Bearing: 0 to 52 feet, S. 43° E.
52 to 123 feet, S. 32° E.

Average depth: 9.0 feet.
Maximum depth: 10.0 feet.
"0" is northwest end or at junction with trench 4.

Interval, feet	Sample		Description
	Petrographic	Chemical	
0 to 106	-	-	Shale, hard sandstone, and no bedding; from 90 to 106 feet, a few small irregular-shaped lenses of silica-carbonate.
106 to 123	85	85	Weathered, brown silica-carbonate with minor amounts of cinnabar from 120 to 125 feet. Cinnabar occurs in high-grade, 1/4-inch short stringers, which are very erratic. Sample 85 is best of mineralization.

Trench 15

Length: 600 feet.
Bearing: 0 to 325 feet, N. 58° E.
325 to 600 feet, N. 65° E.

Average depth: 8.0 feet.
Maximum depth: 9.0 feet.
"0" is northeast end. Dry permafrost (no ice lens) to bottom. 4 feet of overburden is fine silt.

Interval, feet	Sample		Description
	Petrographic	Chemical	
0 to 84	-	-	Thin-bedded shale, soft sandstone, and sandy shale; strike of bedding is S. 70° E., and dip is vertical at 19 feet. At 75 feet, strike of bedding is E. and W., and dip is vertical. Small fragments of silica-carbonate at 54 feet, apparently dragged in by small fault.
84 to 350	-	-	85 percent soft sandstone; rest shale and numerous small faults. At 86 feet, a fault dipping 20° NE. and going under vertical shale beds. At 155 feet, a 2-foot-wide zone of thin-bedded shales striking N. 25° E., dipping 80° E.
350 to 357	69, 70	69, 70	Weathered, brown silica-carbonate sill; strike S. 45° E. and 70° to 90° dip S. Small shale lens at 355 to 357 feet. Other small inclusions of shale throughout. At 356 to 357 feet, rusty red silica-carbonate. Few 1/4-inch stringers of cinnabar with vertical dip. None over 2 to 3 feet long. Mineralization apparent in north wall only; none, in south wall. Sample 69 is best of cinnabar stringers; sample 70 is from 356 to 357 feet. The entire 7-foot face, exposed in the north wall, will assay less than 0.2 percent cinnabar.
357 to 394	-	-	Shale and sandstone.
394 to 410	-	-	Weathered, shattered, brown silica-carbonate; strike S. 75° E. and vertical dip.
410 to 421	-	-	Fault gouge; strike S. 70° to 75° E.
421 to 434	-	-	Shale.
434 to 437	-	-	Silica-carbonate dike; strike S. 15° W. and vertical dip.
437 to 600	-	-	Shale, sandy shale, sandstone, and numerous small faults. Bedding indefinite but appears to strike S. 75° W. At 533 feet, 2-foot vertical silica-carbonate dike striking S. 20° E. with vertical dip. At 552 feet, 1-foot vertical silica-carbonate dike striking S. 30° W.

Trench 16

Length: 220 feet.
Bearing: S. 60° W.

Average depth: 6.0 feet.
Maximum depth: 7.0 feet.
"0" is northeast end. General overburden is very fine silt. Very little rhyolite float.

Interval, feet	Sample		Description
	Petrographic	Chemical	
0 to 14	-	-	Shale, with irregular lens of silica-carbonate.
14 to 26	71 to 73	71 to 73	Partially weathered, brown silica-carbonate dike; strike N. 10° E., and dip is probably vertical. Contacts with shale very irregular. Unweathered parts of dike are light gray. Some cinnabar in irregular-shaped areas not over 1 foot in diameter. Where cinnabar is in weathered part of dike, post mineral movement is often evident. Dike will assay less than 0.1 percent Hg. Sample 71 is best of mineralization; 72 is of weathered portion with cinnabar; 73 is of light-gray dike material with cinnabar.
26 to 134	-	-	Shale, soft sandstone, no bedding planes, and numerous small faults. At 53 feet, 1-inch vertical silica-carbonate stringer, striking S. 35° W. From 125 to 134 feet, harder sandstone--probably a silicified zone.
134 to 220	74, 75	74, 75	Weathered, brown silica-carbonate, pink, fresh-appearing silica-carbonate, and shale. Contact at 120 feet strikes east-west; dip vertical. At 134 feet, cinnabar occurs in a zone, 2 feet long and 4 to 6 inches wide. Well mineralized. Sample 74 is the best of this zone; sample 75 (200 feet) is of pink silica-carbonate.

Trench 17

Length: 371 feet.
Bearing: 0-161 feet, N. 67° E.
161-371 feet, N. 63° E.

Average depth: 5.5 feet.
Maximum depth: 7.0 feet.
"0" is southwest end. Dry permafrost. Overburden consists of about 4 feet of silt, shale, and small amount of rhyolite. Permafrost to bottom of trench. Top 2 feet of bedrock is so badly decomposed that it is hard to distinguish it from overburden.

Interval, feet	Sample		Description
	Petrographic	Chemical	
0 to 28	-	-	Fine-grained, soft sandstone, and some shale.
28 to 52	-	-	Black, fractured shale; could be fault gouge.
52 to 76	63, 64	63, 64	Weathered, brown silica-carbonate dike; strike S. 5° W. and vertical dip. Badly fractured, soft silt or mud on fractures. One small piece of cinnabar found (sample 63). Sample 64 is type specimen of dike.
76 to 78.5	-	-	Black, fractured shale.
78.5 to 81.5	-	-	Same as 52 to 76 feet, except no cinnabar.
81.5 to 100	-	-	Shale and sandy shale.
100 to 101	-	-	Silica-carbonate dike; strike north and south.
101 to 142.7	-	-	Shale, sandy shale, and no bedding.
142.7 to 144	-	-	Weathered, brown silica-carbonate and shale.
144 to 156	-	-	Weathered, brown, shattered silica-carbonate dike; strike S. 5° W.
156 to 160	-	-	Hard sandstone, shale, and some limonite stain; appears to be chill zone.
160 to 236	-	-	Shale, soft sandstone, and sandy shale. Strike of bedding about S. 65° E.; dip is vertical or steeply to southwest.
236 to 238	-	-	Irregular lens of silica-carbonate normal to trench.
238 to 245	-	-	Black shale and black fine mudlike fault gouge.
245 to 255	-	-	Shattered, weathered, brown silica-carbonate sill; dips vertical and strike S. 55° E.
255 to 269	65	65	Black to dark-gray fault gouge.
269 to 277	-	-	Silica-carbonate dike. 4 feet of depth exposed in trench.

Trench 17 (Con.)

Interval, feet	Sample		Description
	Petrographic	Chemical	
-	66	66	Good but erratic cinnabar in south wall, 2 feet from top of dike to bottom of trench. Nothing in north wall. Mineralization is about 18 inches wide and very erratic from 271 to 276 feet. Dike ends abruptly. Sample 66 is most of the deposit. Attempt to follow mineralization with trench 17A failed. Apparently this is a small isolated pocket.
277 to 297	-	-	Shale, black fault gouge and fragments or pockets of silica-carbonate, which are mostly embedded in fault gouge.
297 to 371	67, 68	67	Black fault gouge and shale with isolated fragments or boulders of silica-carbonate embedded in gouge. Sample 67 is type specimen of gouge; sample 68, of silica-carbonate fragments.

Trench 17A

Length: 55 feet.
Bearing: S. 25° W.

Average depth: 6.0 feet.
Maximum depth: 8.0 feet.
"0" is center line of 295-foot point in trench 17. This trench was an attempt to follow mineralization in trench 17.

Interval, feet	Description
0 to 10	Fault gouge.
10 to 19	Shattered, brown silica-carbonate; fault gouge.
19 to 55	Shale, sandstone, and sandy shale.

Trench 18

Length: 243 feet.
Bearing: N. 68° E.

Average depth: 6.0 feet.
Maximum depth: 8.0 feet.
"0" is southwest end; overburden is fine silt; no rhyolite float.

Interval, feet	Sample		Description
	Petrographic	Chemical	
0 to 11	-	-	Shattered shale and an irregular-shaped inclusion of silica-carbonate, about 7 by 5 feet in size, in south side.
11 to 36	76	76	Weathered, brown silica-carbonate and unaltered, very hard, light-gray silica-carbonate. Sample 76 is of altered material. Contact at 36 feet is irregular, but strike is approximately S. 70° E.
36 to 68	-	-	Shale with an irregular-shaped 4- by 6-foot lens of silica-carbonate. Could be a fault zone.
68 to 180	-	-	Shale and sandstone. At 129 feet, a 4-inch-wide silica-carbonate dike (S. 60° E.).
180 to 183.5	-	-	2-foot-wide silica-carbonate dike (S. 65° E.), bedding of sediments striking S. 60° to 70° E., as do small fault planes.
183.5 to 214	-	-	Shale and sandstone.
214 to 229	-	-	Weathered, brown silica-carbonate; strike S. 65° E. and vertical dip.
229 to 243	-	-	Shale and sandstone; strike of bedding S. 65° E. and dip 80° S.

Trench 19

Length: 243 feet.
Bearing: 0 to 90 feet, N. 9° W.
90 to 243 feet, N. 3° W.

Average depth: 8.0 feet.
Maximum depth: 10.0 feet.
"0" is south end.

Interval, feet	Description
0 to 243	Shale, sandy shale, sandstone, and no bedding.

Trench 20

Length: 60 feet.
Bearing: N. 85° W.

Average depth: 6.0 feet.
Maximum depth: 7.0 feet.
"0" is east end.

Interval, feet	Sample		Description
	Petrographic	Chemical	
0 to 16	-	-	Shale and sandstone.
16 to 24	-	-	Silica-carbonate and shale.
24 to 34	90	90	Silica-carbonate dike; strike S. 25° W.; minor amount of cinnabar (less than 0.1 percent), which occurs in small slips and partings.
34 to 38	-	-	Shale.
38 to 44	-	-	Silica-carbonate dike; strike S. 42° W.
44 to 60	-	-	Shale and sandstone.

Trench 21

Length: 324 feet.
Bearing: S. 60° W.

Average depth: 7.0 feet.
Maximum depth: 8.0 feet.
"0" is northeast end.

Interval, feet	Description
0 to 324	Interbedded shale and sandstone.

Trench 22

Length: 453 feet.
Bearing: 0 to 375 feet, N. 80° W.
374 to 453 feet, S. 85° W.

Average depth: 6.0 feet.
Maximum depth: 8.0 feet.
"0" is southeast end. Near top of rhyolite ridge, no frost. Overburden is broken rhyolite.

Interval, feet	Sample		Description
	Petrographic	Chemical	
0 to 208	82	82	Rhyolite, light gray, not weathered; at 121 feet, clay slip (fault) that strikes S. 20° E. and dips 28° W. Sample 82 is type specimen of rhyolite.
208 to 240	-	-	Hard, altered shale and sandstone; strike about normal to trench.
240 to 316	-	-	Unaltered, light-gray rhyolite.
316 to 319	83	83	Altered, rhyolite dike; strike is normal to trench; vertical dip. Considerable quartz along contact.
319 to 453	-	-	Same as 240 to 316 feet.

Trench 23

Length: 326 feet.
Bearing: S. 64° E.

Average depth: 6.0 feet.
Maximum depth: 8.0 feet.
"0" is west end.

Interval, feet	Sample		Description
	Petrographic	Chemical	
0 to 109	-	-	Unaltered, light-gray rhyolite.
109 to 119	-	-	Hard, silicified shale.
119 to 125	84	-	Silica-carbonate dike; strike normal to trench and dip vertical.
125 to 196	-	-	Shale and hard sandstone; no bedding and irregular contacts approximately normal to trench.
196 to 326	-	-	Rhyolite, much bending on flow lines.

Trench 24

Length: 136 feet.
Bearing: N. 35° E.

Average depth: 5.0 feet.
Maximum depth: 7.0 feet.
"0" is southwest end.

Interval, feet	Description
0 to 136	Unaltered, light-gray rhyolite.

Trench 25

Length: 47 feet.
Bearing: N. 35° E.

Average depth: 6.0 feet.
Maximum depth: 8.0 feet.
"0" is southwest end.

Interval, feet	Description
0 to 47	Shale and fault gouge.

Trench 26

Length: 74 feet.
Bearing: 0 to 40 feet, due west.
40 to 74 feet, due south.

Average depth: 7.0 feet.
Maximum depth: 10.0 feet.
"0" is west end.

Interval, feet	Description
0 to 23	Shattered shale.
23 to 56	Weathered, brown silica-carbonate; a few very small lenses of cinnabar.
56 to 74	Shattered shale.

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