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INVESTIGATIONS OF GOSSANS OF HOT SPRINGS DOME, NEAR MANLEY HOT SPRINGS, ALASKA

by Raymond P. Maloney

* open-file report

UNITED STATES DEPARTMENT OF THE INTERIOR

Dr. Rogers C. B. Morton, Secretary

BUREAU OF MINES

Dr. Elburt F. Osborn, Director

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INVESTIGATIONS OF GOSSANS ON HOT SPRINGS DOME, NEAR MANLEY HOT SPRINGS, ALASKA

by

Raymond P. Maloney[1/]

ABSTRACT

Prominent gossans on the summit of Hot Springs Dome were investigated during 1953-54 to determine whether commercially valuable metal sulfides were below the zone of oxidation. The gossan-capped zones are 100 to 500 feet long and 20 to 50 feet wide in metamorphosed sedimentary rocks near their contact with a large body of granitic intrusives. The gossans had been explored superficially and two claims on the strongest gossans had been patented. Various Government geologists and engineers reported the presence of small amounts of lead, zinc, copper, and cobalt sulfides or oxides, but in general the pits and adits had disclosed iron and manganese oxides only.

The Bureau of Mines drilled eight diamond drill holes in 1954 that varied in length from 243 to 515 feet and had a total linear length of almost 3,200 feet. The objective was to penetrate to the zone of primary sulfides but oxidation was practically complete to a vertical depth of slightly more than 400 feet which was the limit of the equipment; however, a small amount of galena in relatively unfractured rock was intersected by one hole. Most of the drill hole intersections were in strongly brecciated rock that was traversed by numerous seams of limonite, goethite, or siderite; some of these seams were several feet wide.

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INTRODUCTION

Conspicuous gossans near the summit of Hot Springs Dome have attracted the attention of mining men since early in the present century. Several examinations and reports had been made by geologists of the Geological Survey, and substantial amounts of trenching, shaft sinking, and tunneling had been done by prospectors who patented two claims on the strongest gossans. Some lead, copper, and cobalt minerals have been found in the outcrops, but otherwise the gossans are composed entirely of iron or manganese oxides and iron carbonates; furthermore none of the prospect workings had penetrated below the zone of oxidation.

In 1953 the Bureau of Mines was engaged in a general investigation of strategic mineral resources in the Manley Hot Springs-Tofty area. The investigation was planned, primarily, to determine the placer reserves and the lode source of tin, columbium, and other strategic minerals which had been found in gold placer deposits in this area, but in view of the fact that these placers may have derived from the same granitic intrusives which are adjacent to the gossans on Hot Springs Dome, it was decided to try to determine the nature of the primary metallization underlying the gossans. Therefore, a reconnaissance-type diamond drilling project was undertaken for this purpose.

In 1954 the results of this work were considered inconclusive and additional work was planned with the intention of combining the data into one report. After further investigations were carried out it was decided that this would not be done. Because of renewed interest in the area this information is being made available by this open-file report.

ACKNOWLEDGMENTS

Acknowledgment is made to Gus A. Benson, U.S. Commissioner, Manley Hot Springs, Alaska for information on claim locations and for assistance in finding the claim owners.

Appreciation is expressed to the Geological Survey for making available advance copies of topographic maps of the area.

LOCATION AND ACCESSIBILITY

The deposit is on Hot Springs Dome which is a conspicuous uplift about 5 miles from the small settlement of Manley Hot Springs, Alaska. The area is in the eastern half of the Yukon River region, Hot Springs subdistrict[2/], at latitude 65°01'51" N. and longitude 150°44'30" W. (Figs. 1 and 2).

Manley Hot Springs, which is situated on a slough off the Tanana River, is the port of entry and the distribution center for a large placer mining area. At the time of this investigation it supported a permanent population of about 20 people who provided the operating personnel for a general store, a post office, a Weather Bureau station with radio facilities, and a roadhouse.

Manley Hot Springs is near the Tanana River approximately 90 airline miles west-northwest of Fairbanks; a barge landing on the Tanana River is connected with the village of 4 miles of dirt road. River boats and barges operate on the Tanana and Yukon Rivers from about the middle of June to the last of September, and make connections with the Alaska Railroad at Nenana and at Fairbanks. An improved gravel road about 150 miles long extends from Fairbanks to Manley Hot Springs via Livengood. Light freight, passengers, and emergency supplies are carried by small planes operating from Fairbanks on a scheduled or charter basis.

2/ Ransome, A. L., and Kerns, W. A., Names and definitions of regions, districts, and subdistricts in Alaska: Bureau of Mines Inf. Circ. 7679, 1954, 64 pp.

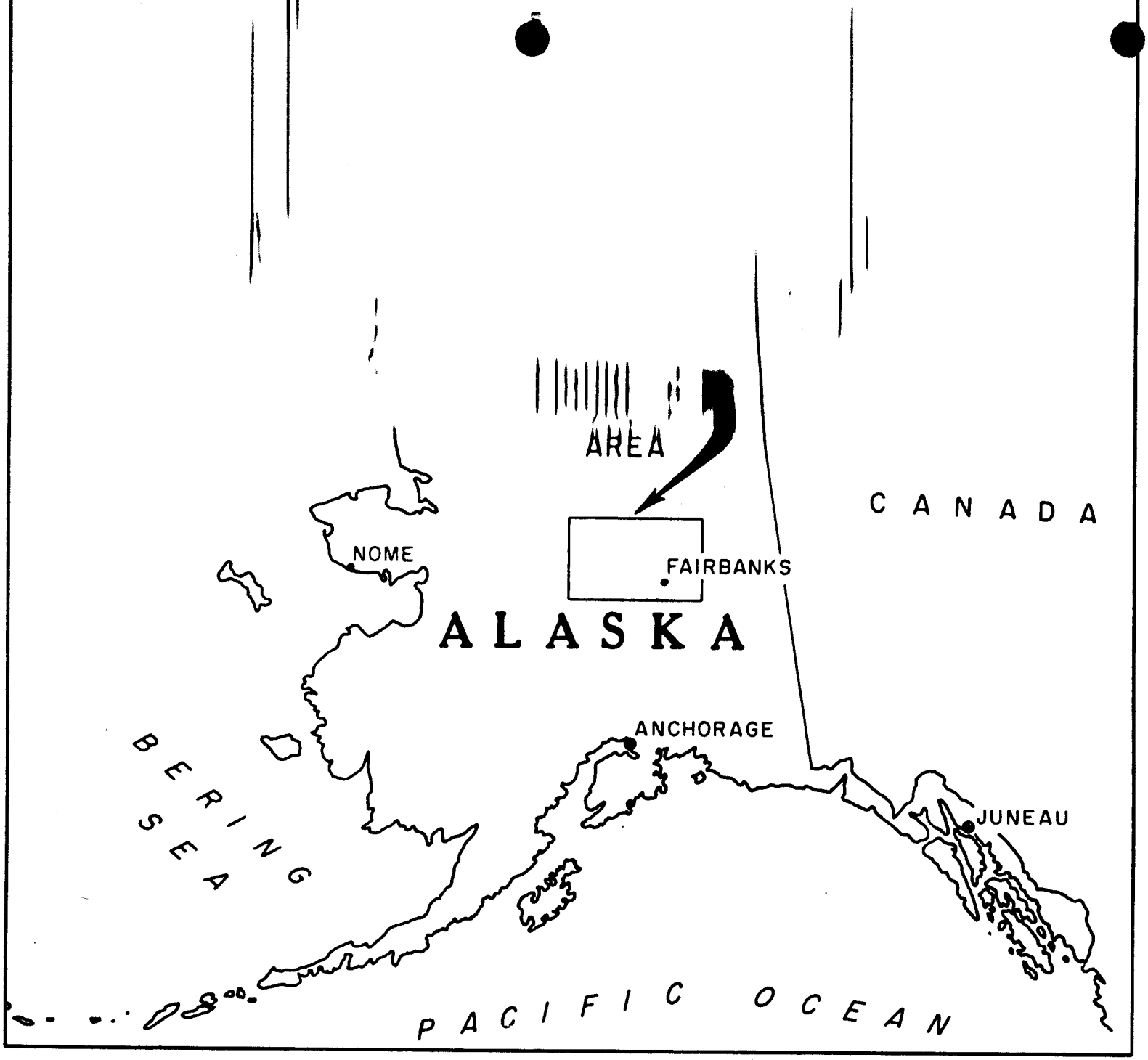

FIGURE 1.- Index Map of Alaska.

Dirt and gravel roads connect Manley Hot Springs with placer camps at Tofty and Eureka. An unimproved access road, suitable only for four-wheel drive vehicles, was constructed to within one and a half miles of the summit of Hot Springs Dome; a tractor trail, unsuitable for wheeled vehicles, continues to the summit.

HISTORY AND OWNERSHIP

The exact date of the discovery of the metal-bearing lodes on Hot Springs Dome is not known but it may be assumed that the outcrops were found during the 1890's when the gold placer deposits between Rampart and Tofty (see fig. 2 and 3) were being prospected and developed. However, no serious attempt to explore the lodes was made until 1914 when John J. Barrett, who had worked in Butte, Montana, saw a similarity between the manganese-stained gossans on Hot Springs Dome and the outcrops of the lodes at Butte. Mr. Barrett staked the Iron Mask lode claim in 1914 and the adjoining Granite Quartz lode claim (fig. 4) in 1924; both claims were patented in 1937.

Mr. Barrett sank 3 shafts and drove a short adit on the Iron Mask claim. The shafts, estimated to be about 20 feet deep, are partly caved and are filled with water and ice to within 6 feet of the collars; the adit is about 20 feet long. Several trenches and a number of small prospect pits were excavated on the claims and in the general vicinity of the claims. The positions of these various workings are shown on figure 4. The remains of a small cabin, now uninhabitable, are about 3,000 feet south of the mine workings.

Except for the Bureau project, no work has been done on the Hot Springs Dome deposits since Mr. Barrett's death in 1942. Title to the

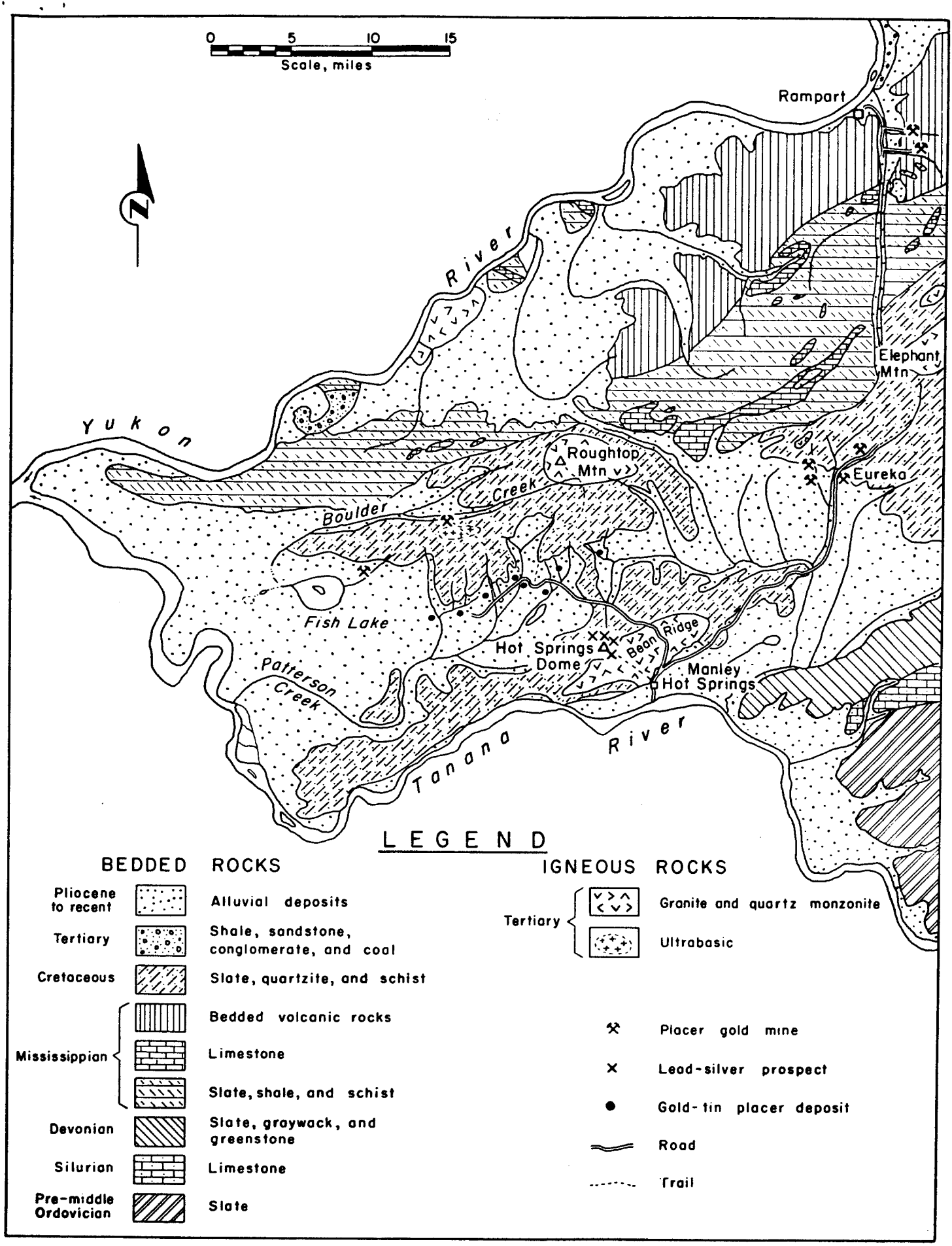

FIGURE 3.- Geologic Map, Parts of Hot Springs and Rampart Districts, Central Alaska.
Geology from Geological Survey Circular 317.

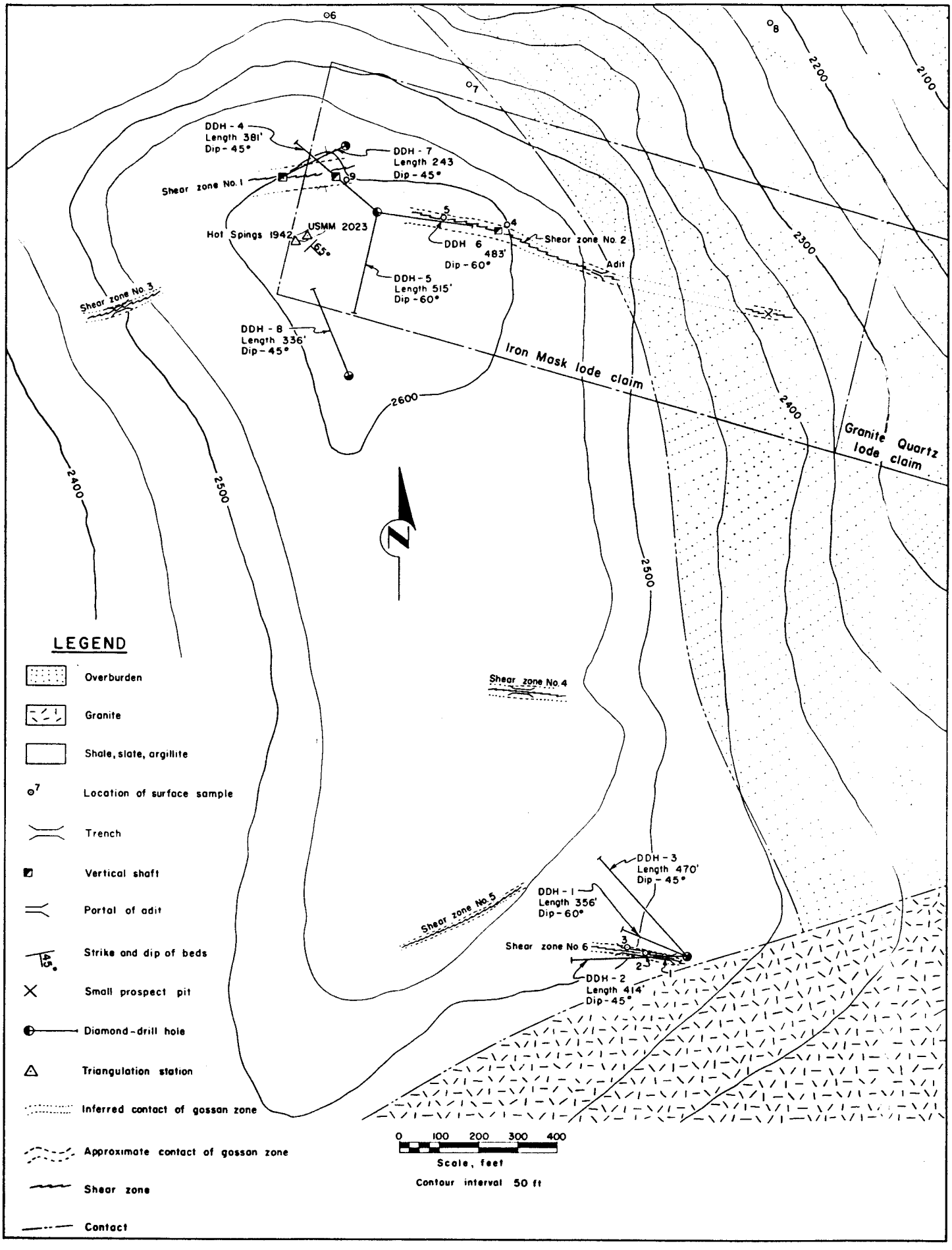

FIGURE 4.- Geologic and Topographic Map of Hot Springs Dome, Alaska.

claims is in the estate of J. J. Barrett which in 1957 was being administered by J. F. Emigh, Attorney-at-Law, 47 North Main St., Butte, Montana.

PHYSICAL FEATURES AND CLIMATE

Hot Springs Dome, altitude 2,650 feet, is the highest part of a long, narrow ridge which separates the Tanana River valley from a parallel valley that is occupied by Patterson Creek and by Baker Creek which flow west and east respectively from a low divide almost due north of the Dome. The ridge, which is known as "Bean Ridge," trends from the Dome about S. 60° W. 15 miles and about N. 70° E. 12 miles, on a gradual slope in each direction until it merges into the adjacent valleys. The mineral deposits, which are the subject of this report, are on the plateau-like summit of Hot Springs Dome (fig. 4) where the relatively thin mantle of overburden has permitted a large exposure of gossan. The only exposure of bedrock, however, is a jagged outcrop of slate about 50 feet in diameter and about 20 feet high near the northern end of the plateau.

Except on the plateau at the Dome, the rounded summit of Bean Ridge down to about the 1,500 to 2,000-foot contour is covered deeply with coarse detritus which includes many large boulders and which, except where the large boulders are exposed, is in turn covered with muskeg and scattered small bushes. Road or trail construction on this surface is extremely difficult.

The sides of the ridge below the rounded summit slope more or less uniformly to the valleys at approximately a 20 percent average grade. The upper parts of the slopes are covered with thick brush which gradually gives way to a dense growth of small birch on the southern slopes or to

spruce, willow, and alder on the northern slopes. On the lower slopes, trees up to 2 feet in diameter are common. The top soil within the forest covered areas generally is deep, well drained, and free from boulders; therefore, pioneer road or trail construction may be accomplished at minimum cost.

The climate is typical of the Yukon valley; the winters are long and cold, with temperatures down to 60° F. below zero; the summers are short and warm, with temperatures occasionally up to 90° F. or more. The annual precipitation is 10 to 12 inches; most of the precipitation falls as rain from June through September. The total winter snowfall averages about 50 inches.

DESCRIPTION OF THE DEPOSIT

General Geology

The geology of the area has been mapped and described on a reconnaissance basis only. From data supplied by earlier investigators and by field work performed during the summer of 1911, Eakin described the geology of the area and prepared a generalized geologic map; he mentioned the existence of gold-bearing "hematite deposits"3/ near Hot Springs and Rough Top Mountain as possible sources of the gold placers. In 1934, Mertie reviewed earlier reports and added his personal observations that were obtained during a visit to the district in 1931; he described briefly the Barrett prospect on

3/ Eakin, Henry M., A Geological Reconnaissance of a part of the Rampart Quadrangle, Alaska: Geol. Survey Bull. 535, 1913, 30 pp.

Hot Springs Dome.[4] The most recent published report[5] by Moxham in 1948 although concerned chiefly with the occurrence of radio-activity in the district, presents a small scale (1 inch = 10 miles) geologic map which differs in several details from the earlier map by Eakin; Moxham also included a short description of the Barrett prospect and of the adjacent granitic intrusives.

The geologic map by Moxham (reproduced in Fig. 3) shows that the gold and tin-bearing parts of the Manley Hot Springs-Rampart district is underlain chiefly by Mississippian and Cretaceous sediments most of which are slate or shale, quartzite, or schist. These sediments are intruded by several granitic stocks of Tertiary age which are exposed on Hot Springs Dome, on Roughtop Mountain, and on Elephant Mountain. Although no relationship between the granitic intrusives and the placer deposits has been proved, it appears to be significant that most of the placer deposits are on streams which are between, or adjacent to the granitic exposures.

The granitic rocks on and near Hot Springs Dome are exposed throughout an area about 10 miles long by 2 1/2 to 3 miles wide along the south slope of Bean Ridge; the north contact is nearly parallel to, and largely coincident with the crest of Bean Ridge. The metamorphosed sedimentary rocks north of the contact are hornfels, slates, and schists which strike about N. 45° E. and dip about 60° southeast.

4/ Mertie, J. B., Jr., Mineral Deposits of the Rampart and Hot Springs Districts, Alaska: Geol. Survey Bull. 844-F, 1934, pp. 215-226.

5/ Moxham, Robert M., Reconnaissance for Radioactive Deposits in the Hot Springs-Rampart District, Central Alaska: Trace Elem. Inves. Report 54, Geol. Survey, 1952, p. 8.

The Deposits

The lode deposits on Hot Springs Dome are in the metamorphosed sedimentary rocks of a small re-entrant into the northern contact of the granitic intrusives (fig. 3). The metal-bearing deposits are in zones up to 50 feet wide of undetermined length approximately parallel to the granite-sedimentary contact. The zones have been described as "shear" zones[6/], but they are so poorly exposed and so highly oxidized that the amount of shearing is not clear; they may be zones of fracturing and brecciation in which very little shearing has been involved. The lengths, widths, and mutual relationships of these zones insofar as they have been determined by trenches, by diamond drill holes, and by gossan are shown on figure 4. The gossan overlying Zones No. 1, No. 2, and No. 6 is much stronger than the gossan overlying the other zones; the gossan over Zones No. 4 and No. 5 is very weak. The zones which appear to have been intersected by drill holes No. 3 and No. 5 were not identified on surface.

The metal-bearing zones are composed chiefly of fractured and variously metamorphosed argillitic rocks which are traversed by numerous seams of iron oxides and by a few seams of iron carbonates and calcium carbonates; quartz veinlets are numerous also. The larger seams of iron oxides may be as much as several feet wide; they appear to be fracture fillings which conform to the trend of the zone. The smaller seams are fracture fillings which traverse the argillitic rocks at all angles; in other words they appear to

6/ Work cited in footnotes 4 and 5, p. 10.

fill the interstices of a very coarse breccia. Sulfide cavities near the margins of some seams indicate that some dissemination had taken place, but in general the rock between the seams is barren.

Some galena, coated with anglesite, was found near the collar of one of the shafts in Zone No. 1 and some small pieces of slate coated with erythrite were found near the east end of Zone No. 1. Very small amounts of pyrite and chalcopyrite may be found on surface; some galena in calcite was obtained near the bottom of drill hole No. 5. Otherwise the metal-bearing minerals consisted chiefly of limonite and geothite with considerable pyrolusite and some hematite, magnetite, and rutile. Oxidation was practically complete to 446 feet below surface - the greatest depth reached. Although the fresh galena in hole No. 5 was nearly 400 feet below surface, it was in a minor fracture zone where it may have been protected from the action of descending waters. Probably for the same reason a small amount of pyrrhotite, chalcopyrite, and pyrite was in a small stringer at a depth of only 18 feet in hole No. 1.

WORK PERFORMED BY THE BUREAU OF MINES

Mechanical Operations

In the fall of 1953 an old truck trail up the south side of Hot Springs Dome was rehabilitated and about 2 miles of tractor trail were cleared beyond the end of the truck trail. Equipment and supplies were delivered to the summit of the Dome during the late spring of 1954 and a tent camp was established. Diamond drilling was started near the end of June and was continued until freezing weather stopped operations on September 16. During this period 3,197.9 linear feet of drill hole were completed in 8 holes whose depth ranged from 243

to 515 feet.

Permafrost was encountered in each hole at about 15 feet and continued to depths of about 150 feet. Because of the permafrost, continuous circulation of drilling water was required throughout the duration of drilling operations in each hole; otherwise the water would freeze solid within about 2 hours.

Until July 18 water for drilling was obtained by channeling muskeg water through ditches into catch basins; this supply was conserved by settling the sludges and recirculating the water. After July 18 water was obtained by pumping through plastic pipe from a small stream about 2,000 feet from the drill site.

Exploratory Operations

The chief objective of the drilling was to determine, if possible, the nature and approximate intensity of the primary metallic mineralization from which the extensive gossans had been derived; therefore, the holes were located to provide reconnaissance-type data below differing phases of the outcrops. Because the deepest holes of which the equipment was capable (515 feet hole depth, 446 feet vertical depth) failed to encounter primary metallization except in very small protected pockets, no attempt was made to systematically explore any of the metal-bearing structures.

Chemical analyses of surface and diamond core drill samples are given in Tables 1 and 2.

Graphic logs of each of the holes are presented in figures 5 through 12. Detailed descriptive logs of each hole are presented in the Appendix.

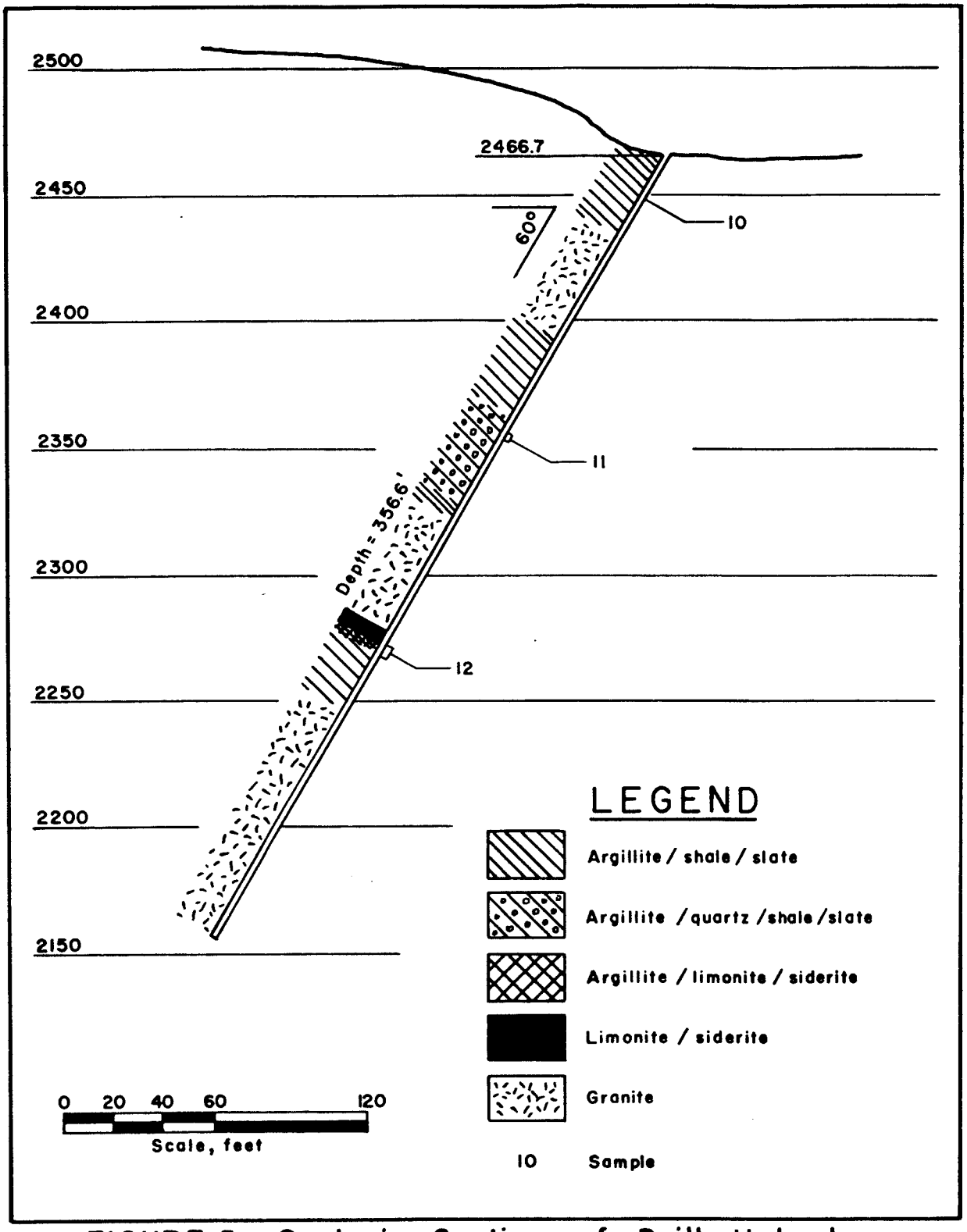

FIGURE 5.- Geologic Section of Drill Hole 1

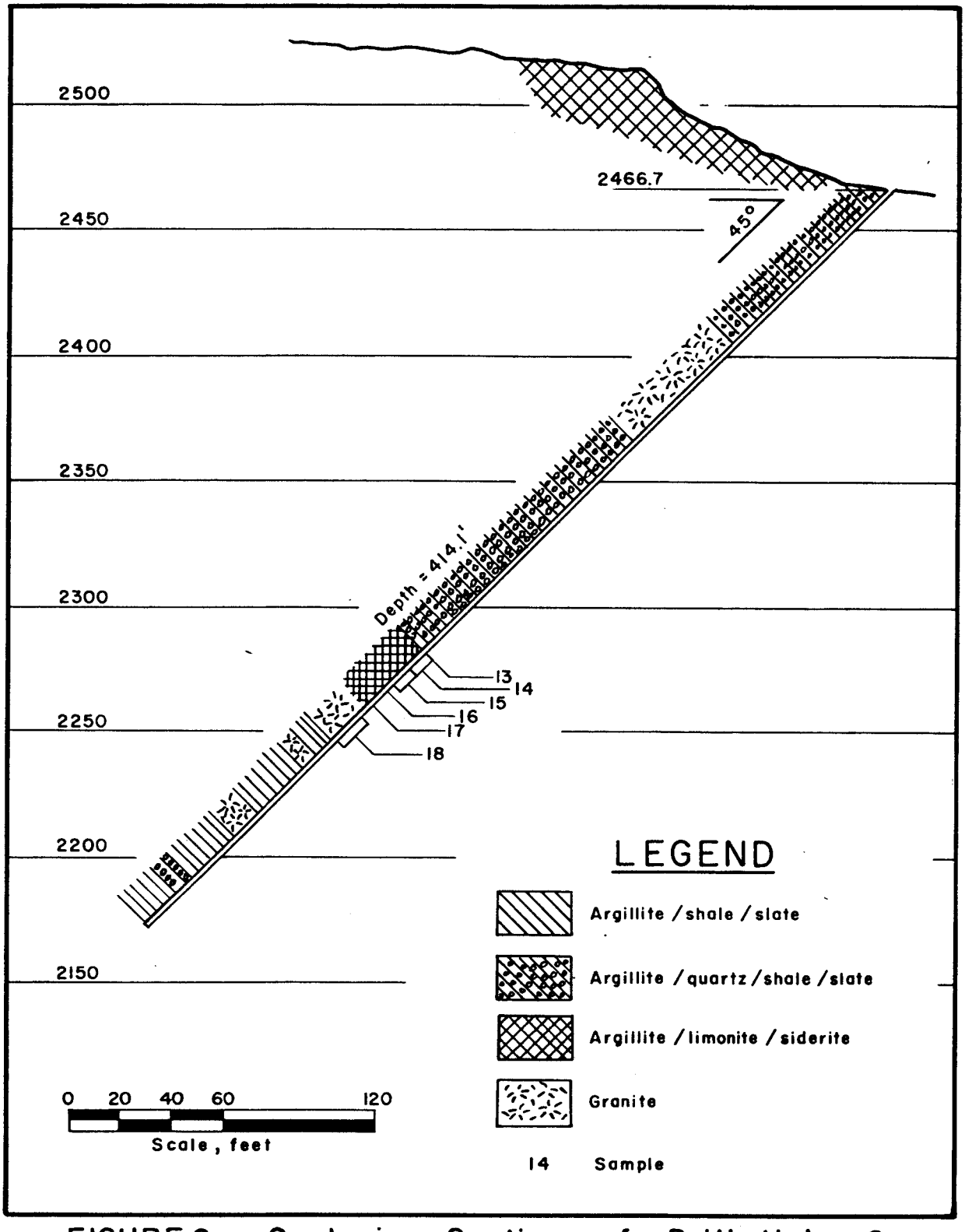

FIGURE 6. – Geologic Section of Drill Hole 2

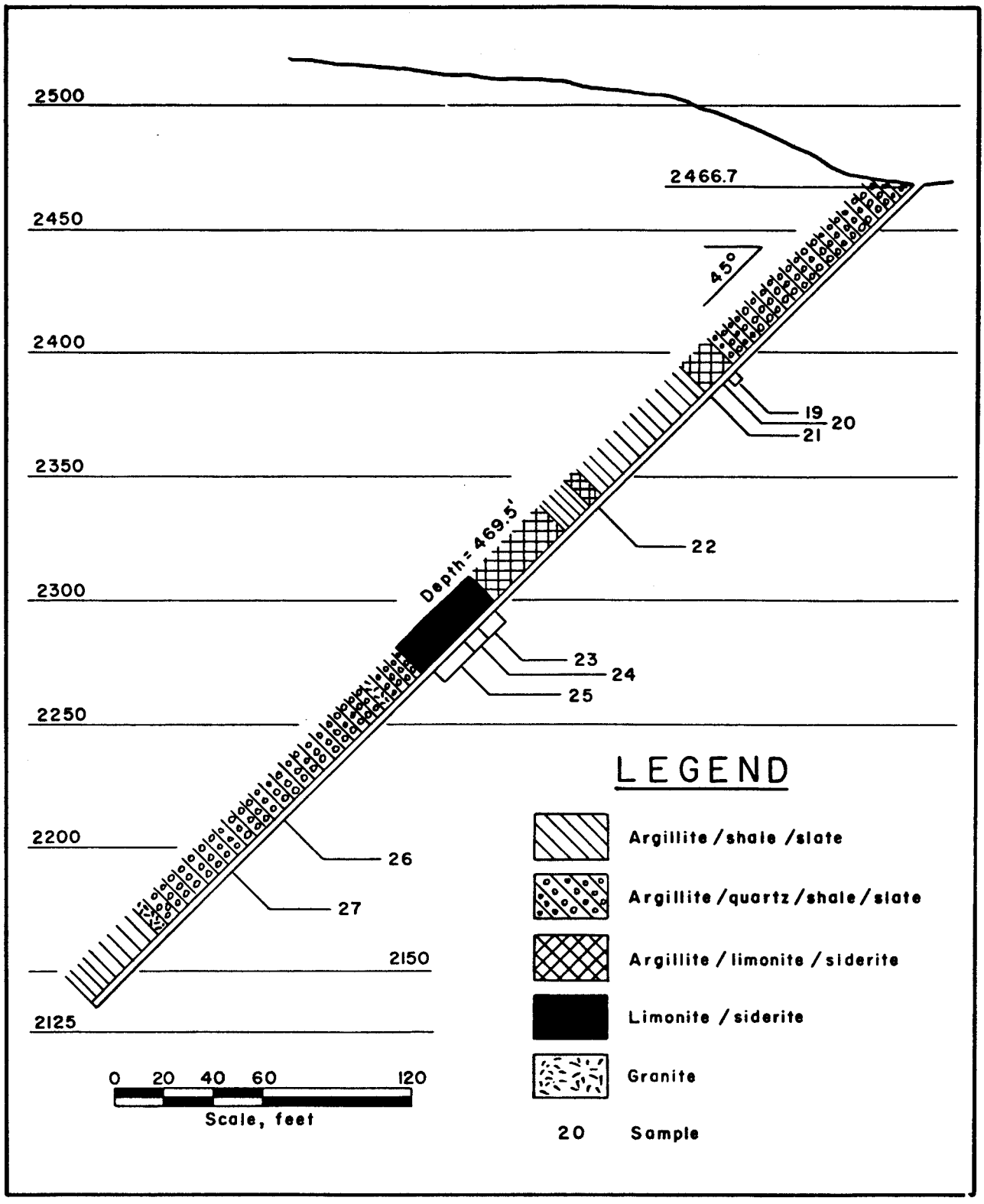

FIGURE 7.- Geologic Section of Drill Hole 3

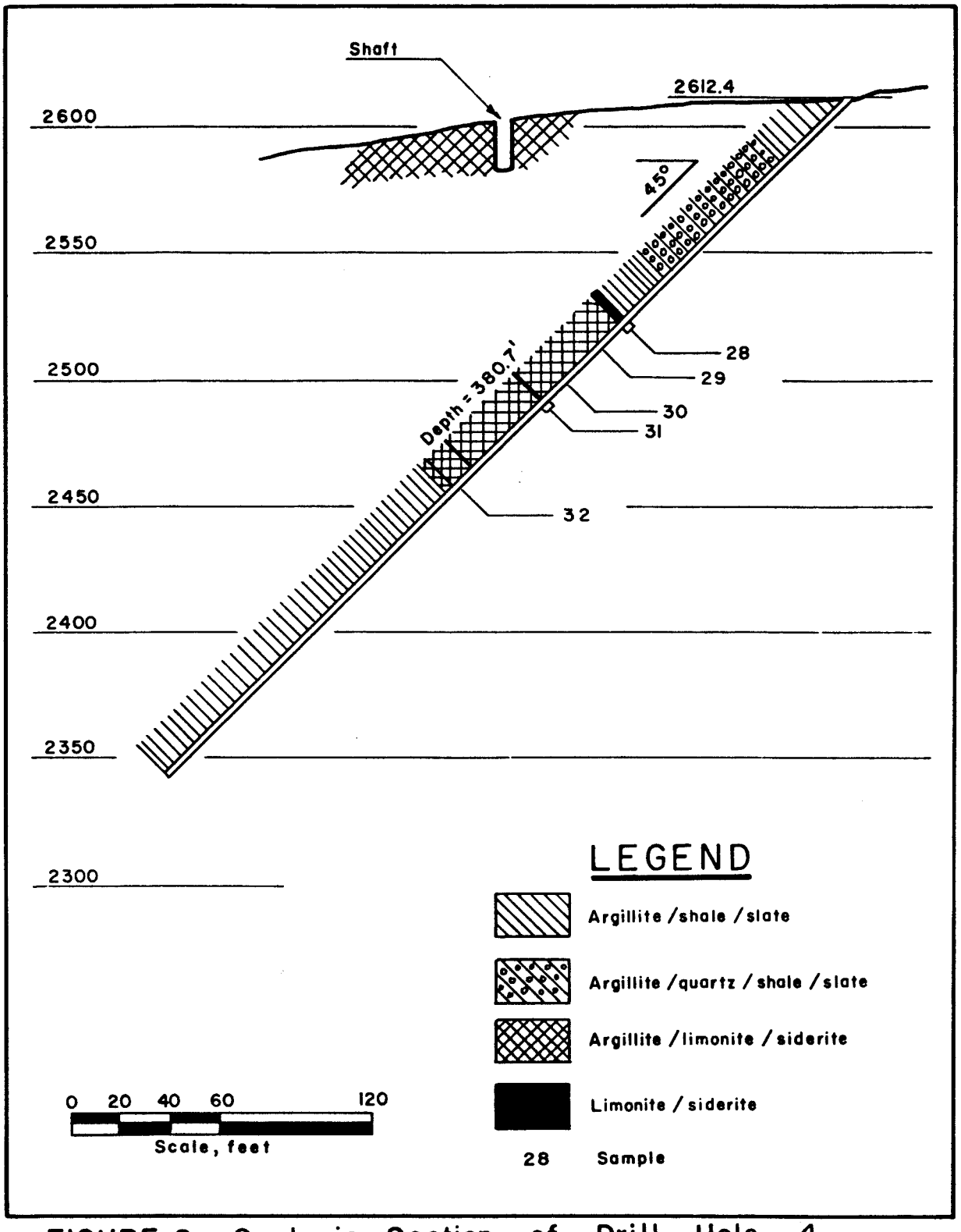

FIGURE 8.– Geologic Section of Drill Hole 4

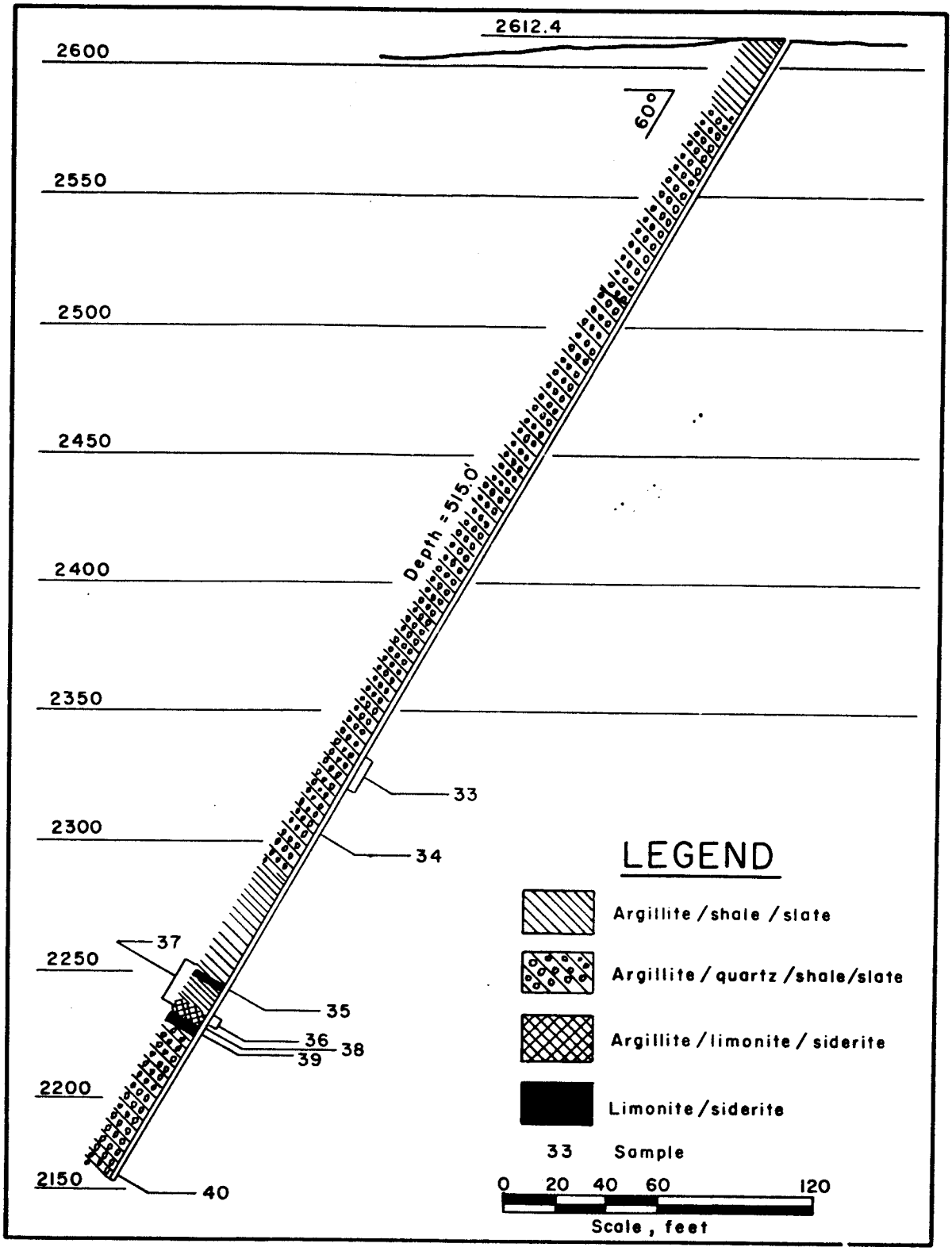

FIGURE 9.- Geologic Section of Drill Hole 5

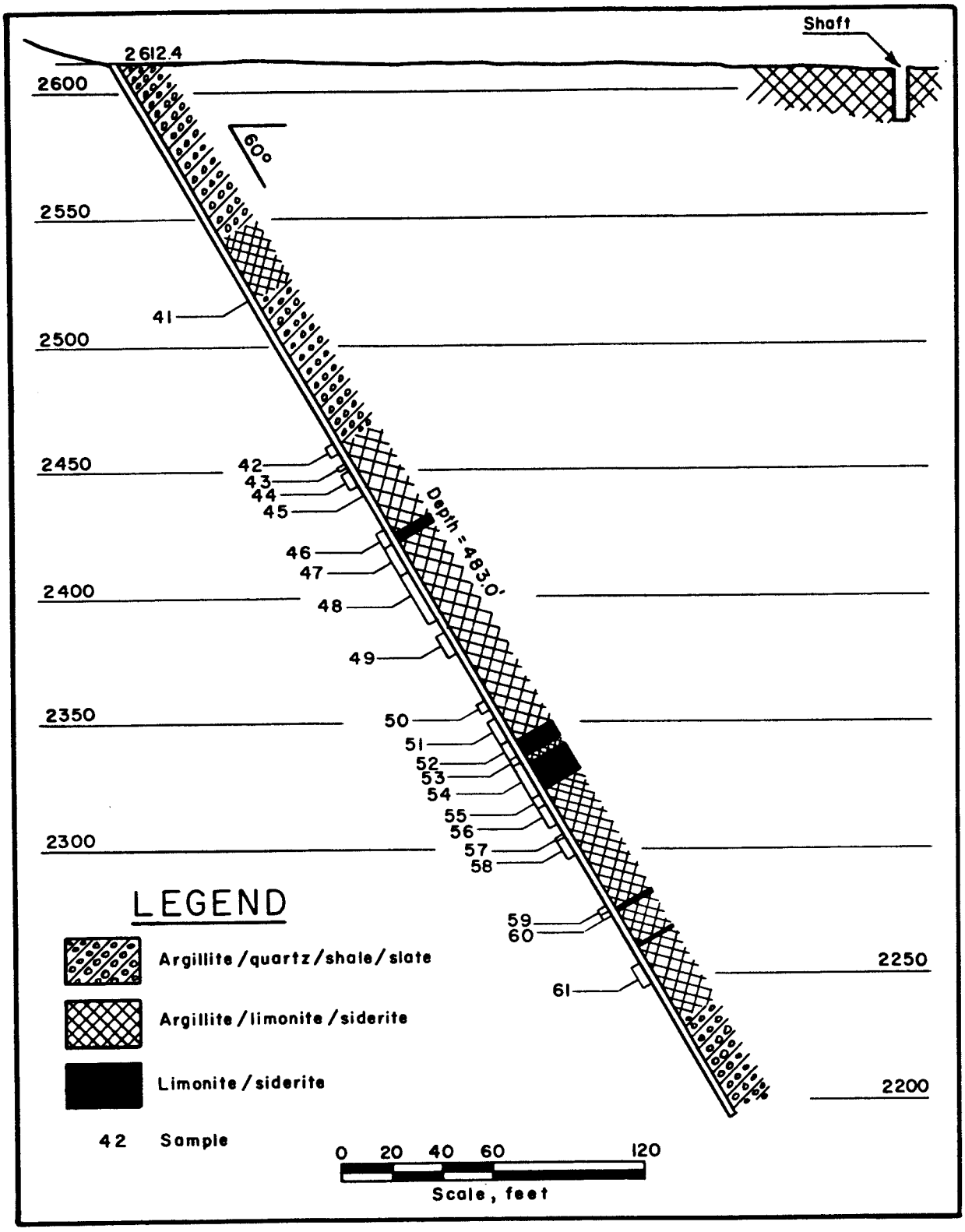

FIGURE 10.- Geologic Section of Drill Hole 6

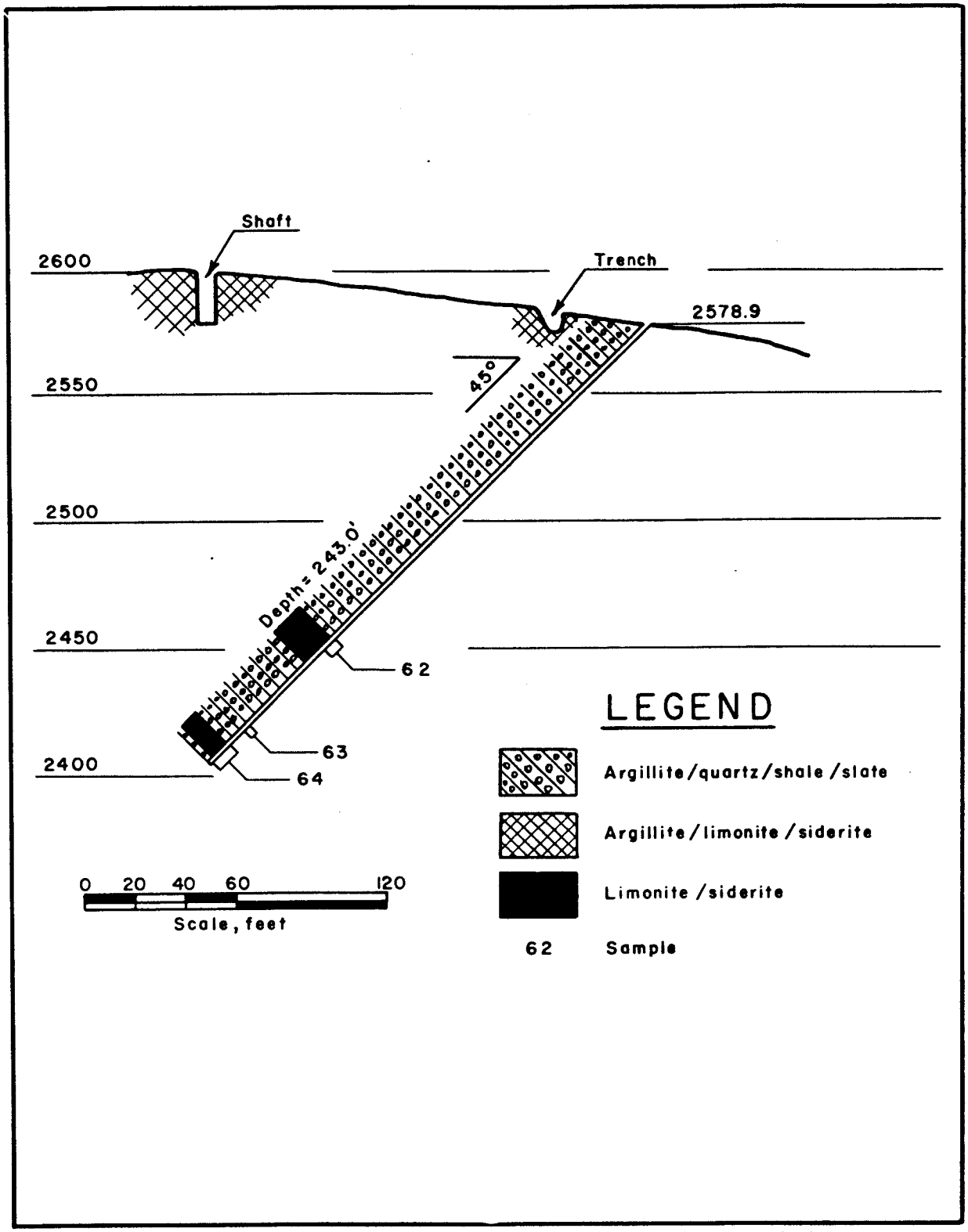

FIGURE 11.— Geologic Section of Drill Hole 7

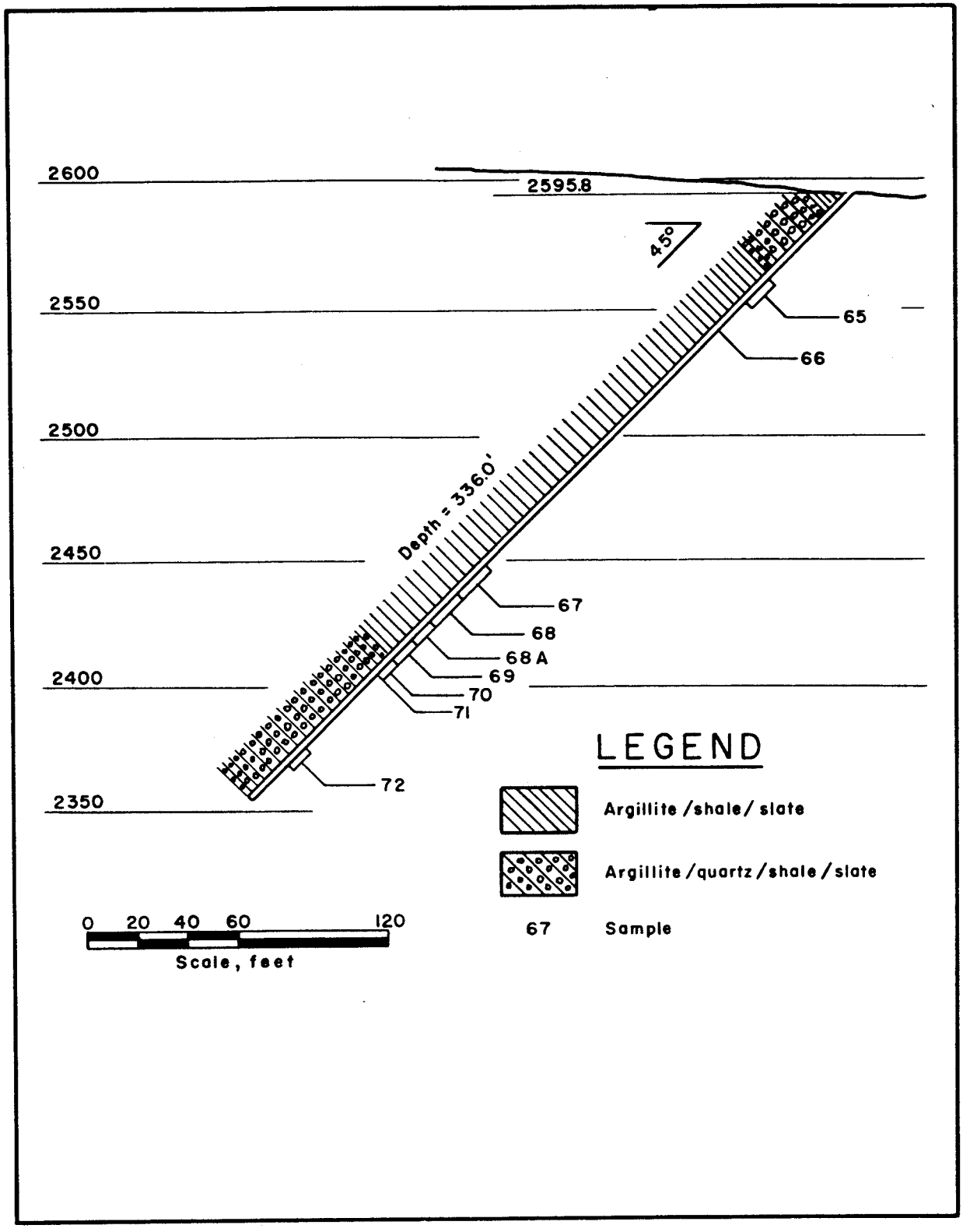

FIGURE 12.- Geologic Section of Drill Hole 8

APPENDIX

Logs of Diamond Core Drill Holes

Hole No. 1

Bearing: N. 66 degrees W. Inclination: -60 degrees

Elevation of collar: 2,466.7 ft. Depth: 356.6 ft.

Size: AX 0-18.1 ft.; EX 18.1-356.6 ft.

Distance From Feet	Distance To Feet	Core Recovery Percent	Description
0	37.7	90	Dark grey, fine grained massive argillite; last 10 ft. is faintly banded and lighter in color with irregular small quartz and pyrite stringers; 18.3 to 18.5 ft. is almost massive pyrrhotite with small blebs chalcopyrite; rusty iron stain on fractures. Sharp clean contact with granite at 37.7 ft.
37.7	46.2	95	Light to flesh colored biotite granite.
46.2	52.8	95	Rusty, altered granite; many limonite stringers.
52.8	83.5	86	Flesh colored biotite granite porphyry, slightly rusty stain in few places. Last 8 ft. is fine grained, lighter colored and with less biotite. Sharp contact with argillite at 83.5 ft.
83.5	90.1	100	Dark grey argillite and slate; 2 small (.1 in.) graphite veins at contact with granite; numerous small quartz stringers; small veinlets and lenses of pyrite. Pyrite altered to limonite in places.
90.1	119.5	95	Dark grey schistose argillite with up to 0.4 ft. layers of fine grained, light colored quartzitic rock parallel to schistosity. Schistosity is 20° to long axis of core; 0.4 ft. light quartzitic rock at 107 ft. Small veinlets and irregular lenses of pyrite scattered throughout core. Brown iron stain on fractures.
119.5	124.7	95	As above but with flesh-colored quartz layers and veins 1 to 9 inches wide. Considerable pyrite in irregular masses in both argillite and quartz. Pyrite altering to dark brown limonite.

Log of Diamond Core Drill Hole No. 1 (cont'd.)

Distance From Feet	Distance To Feet	Core Recovery Percent	Description
124.7	159.0	100	Dark grey thin bedded slate and sandstone; numerous bands light grey quartzitic rock; irregular masses of pyrite, especially at or near quartzitic bands.
159.0	159.7	100	Light flesh colored vein of quartz with contact parallel to schist, small vugs in vein; reddish brown iron stain on fractures.
159.7	166.4	100	Dark grey, fine grained, banded shale. Sharp contact with biotite granite at 166.4 ft.
166.4	213.5	97	Light colored biotite granite, no mineralization except for brownish red to black limonite stain on fractures; 1/8 in. pyrite vein at 169.3 ft., 1/8 in. siderite veins at 169.3 and at 211.5 ft.
213.5	217.0	90	Biotite granite with siderite and feldspar. Very little pyrite; 1/2 in. siderite vein at 214.7 ft. Granite gives place to massive limonite and siderite.
217.0	223.1	90	Massive siderite with irregular vuggy portions of limonite.
223.1	227.6	100	Limonite and slate, irregular vuggy reddish brown limonite, no visible pyrite, core broken.
227.6	237.0	70	Grey, fine grained, quartzose slate, irregular and scattered patches of pyrite. Iron stain on fractures.
237.0	252.9	100	Dark grey very fine grained quartzose slate; no mineralization; granite contact at 252.9 ft.; 1 in. zone of transition from schist to granite.
252.9	270.0	100	Biotite granite porphyry; 1/4 in. siderite vein at 255.4 ft. Some granite is flesh colored.
270.0	356.6	100	Fresh light grey biotite granite, a few small siderite veins scattered throughout core, granite is much altered and rusty at 311-312 ft., and somewhat less rusty colored at 314-320 ft. End of hole is in fresh unaltered granite.

Hole No. 2

Bearing: S. 89 degrees W. Inclination: 45 degrees

Elevation of collar: 2,466.7 ft. Depth: 414.1 ft.

Size: AX, 0-42 ft., EX 42-414.1 ft.

Distance From Feet	Distance To Feet	Core Recovery Percent	Description
0	90.0	95	Dark grey fine grained argillite. Scattered 1/4 - 1/8 in. pyrite veins; core is 5% quartz lenses from 32-70.1 ft. At 63.5 ft. is 0.5 in. band of white to flesh colored aplite which has a few irregular patches of pyrite; vugs lined with iron stain. Quartz is unaltered.
90.0	142.0	100	Flesh colored to grey biotite granite with an occasional 1 - 2 in. aplite dike, last 5 ft. of core is finer grained, more flesh colored, and with less biotite. Fractures are rust colored.
142.0	149.6	100	Dark grey, very thin bedded, fine grained, argillite and shale; numerous quartzose bands.
149.6	201.4	100	Dark grey, thin bedded, argillite and shale; numerous veins of quartz and biotite, and small patches or blebs of biotite. Occasional 1/8 in. vein of pyrite. Quartz veins up to 5 in. thick but average 1/2-1 in. Slightly rusty stain on joints. Fine grained dike from 187 to 187.5 ft.
201.4	260.2	100	Dark grey, thin bedded, argillite and shale with numerous bands of quartzose argillite, and scattered 1/6 in. pyrite veins. Several bands or dikes of aplite 2-9 in. wide. Slight rust stain on joints and fractures.
260.2	261.1	100	Massive limonite; core broken. 1 in. layer of light rusty colored altered granite at 260.9 ft.
261.1	293.2	65	Brecciated argillite with limonite matrix and numerous 1/4-1/16 in. limonite veins. Almost massive limonite at 276.5-276.9 ft., 282.8-283 ft., and 289.4-290 ft.
293.2	310.9	60	Fractured, rusty feldspar granite changing to biotite granite at 310.9 ft. Siderite veins in granite.

Log of Diamond Core Drill Hole No. 2 (cont'd.)

Distance From Feet	Distance To Feet	Core Recovery Percent	Description
310.9	319.4	50	Dark grey, fine grained, argillite and shale with few scattered siderite veins 1/32 in. wide.
319.4	326.3	78	Biotite granite, with a few siderite veins 1/32 in. wide. Between 323.8 - 326.3 ft. granite gradually changes to argillite.
326.3	352.8	88	Quartzose argillite with 7 in. of apatite and argillite at 341.0, and 10 in. of light grey biotite granite at 251.4.
352.8	365.2	95	Light grey fresh biotite granite.
365.2	388.1	100	Dark grey, fine grained, argillite and shale, 1 in. of vuggy pyrite at 270 ft., occasional 1/8 in. siderite vein.
388.1	397.6	100	Quartzose argillite with numerous veins and bands of quartz. A 4 in. vein of rose colored quartz at 393.6 ft.
397.6	414.1	85	Quartzose argillite and shale, with several thin siderite veins and several 1 in. bands of light colored feldspar. A 3 in. vein of flesh colored feldspar at 411.5 ft. End of hole is in argillite.

Hole No. 3

Bearing: N. 41 degrees W. Inclination: 45 degrees

Elevation of collar: 2,466.7 ft. Depth: 469.5 ft.

Size: AX, 0-39.7 ft., EX 39.7-469.5 ft.

Distance From Feet	Distance To Feet	Core Recovery Percent	Description
0	105.3	81	Dark grey shale and quartzose argillite, with occasional 1/16 in. siderite veins and numerous quartz veins. Light grey or smoky quartz veins at: 9 in. at 18 ft., 4 in. at 36 ft., 1 in. at 39.7 ft., 8 in. at 55.9 ft., 3 in. at 58.7 ft., 7 in. at 60 ft., 15 in. at 90.5 ft., 6 in. at 97.5 ft.

Log of Diamond Core Drill Hole No. 3 (cont'd.)

Distance From Feet	Distance To Feet	Core Recovery Percent	Description
105.3	121.2	57	Badly broken quartzose argillite with considerable limonite and siderite, 4 in. massive limonite at 112 ft. Rusty coating on joints.
121.2	180.4	80	Dark grey argillite and shale with bands of light grey quartzose argillite; 4 in. quartz vein at 171.7 ft., core badly broken, slight rusty stain on joints.
180.4	186.3	88	Dark grey argillite with massive limonite at: 11 in. at 182.7 ft., 14 in. at 184.3 ft., 8 in. at 185.8 ft.
186.3	198.8	95	Argillite and quartzite.
198.8	237.2	92	Dark grey argillite and shale with siderite and quartz stringers; 50% siderite from 203.9-205.2 ft.; a 7 in. quartz vein at 232.5 ft.
237.2	238.6	56	Rusty argillite and siderite.
238.6	276	82	Massive, flesh to dark brown colored limonite with some siderite and argillite.
276	297.4	89	Dark grey shale and argillite core is 50% quartz from 276-277.6 ft. Biotite granite at 297.4 ft.; sharp contact.
297.4	302.4	100	Light grey altered biotite granite with 1/4-1/8 in. siderite veins.
302.4	425.4	82	Dark grey shale, argillite, and quartzose argillite, with numerous quartz veins up to 12 in. wide. Siderite and pyrite is found in some of quartz veins. Core well broken, with very little iron stain on joints. Last 2 in. before granite contact is quartz and argillite.
425.4	431.2	90	Flesh colored to light grey, altered biotite granite with limonite.
431.2	469.5	93	Dark grey, banded quartzose argillite, with 3 in. quartz veins at 436.5 ft. and 440 ft. A few 1/4-1/2 in. limonite stringers.

Hole No. 4

Bearing: N. 49° W. Inclination: 45°

Elevation of collar: 2,612.4 ft. Depth: 380.7 ft.

Size: AX, 0-11, EX 11-380.7

Distance From Feet	Distance To Feet	Core Recovery Percent	Description
0	37.7	100	Dark grey slate and shale with a few 1/8 - 1/4 in. quartz stringers.
37.7	103	74	Dark grey, fine grained, argillite and shale with numerous 1/4 to 13 in. quartz veins, and a few limonite and siderite stringers, 4 in. of massive limonite at 48 ft. Rusty iron stain on joints. Core badly broken.
103	125	55	Core broken and fractured, dark grey quartzose argillite and shale, 5 in. quartz vein at 124 ft. Rusty iron stain on joints.
125	128	80	50% dark grey argillite and 50% dark brown limonite; occasional, small amounts of quartz.
128	182	52	Dark grey banded argillite and shale, with considerable dark brown to reddish brown massive limonite. 6 in. of massive limonite at 140 ft.; 25 in. quartz vein at 158.5 ft.; 6 in. of massive limonite at 157.6 ft.; 19 in. of massive limonite at 169.8 ft.
182	217	45	50% limonite and 50% argillite and slate. Argillite is dark grey and fine grained; 8 in. quartz vein at 190 ft.; 14 in. quartz vein at 213.8 ft.
217	220	95	Massive rusty siderite with a little argillite.
220	223	72	Massive rusty siderite and argillite.
223	260	35	Dark grey, fine grained, banded argillite.
260	380.7	65	Dark grey, fine grained, argillite and slate with few 1/4 in. siderite veins.

Hole No. 5

Bearing: S. 13° W. Inclination: 60°

Elevation of collar: 2,612.4 ft. Depth: 515.0 ft.

Size: AX 0-27.5 ft.; EX 27.5-515 ft.

Distance From Feet	Distance To Feet	Core Recovery Percent	Description
0	42.2	75	Grey schistose slate with a few 1/8 - 1/16 in. brown siderite veins. 18" smoky colored quartz vein at 36.5 ft. and a 10" similar quartz vein at 38.6 ft.; core is badly broken. Slight iron stain on joints.
42.2	91.8	84	Dark grey argillite and slate with numerous lenses and stringers of quartz and a few 1/4 - 1/8" veins of siderite.
91.8	120.3	33	Dark grey, fine grained, argillite and slate with thin lenses of quartz. Core is badly broken.
120.3	121.2	80	Light rusty zone of siderite and argillite.
121.2	325	73	Dark grey, fine grained, quartzose argillite with occasional bands of black, fine grained, shale and a few 1/16 - 1/8" veins of siderite; occasional traces of pyrite; 2" and 3" quartz veins at 276 and 277 ft. respectively. Considerable more quartz from 259-279 ft. and from 290-298 ft.
325	379	48	Dark grey, banded argillite with considerable quartz and quartz veins up to 6" wide. A few small siderite veins.
379	429.3	88	Dark grey, banded quartzose argillite and slate with a few small stringers of siderite. A 7" quartz vein at 400.6.
429.3	430.8	100	50% dark brown limonite with white calcite stringers.
430.8	439.5	90	Dark grey argillite.
439.5	446.6	71	Dark grey argillite with dark brown limonite stringers and white calcite veins. Occasional blebs of galena in calcite veins.

Log of Diamond Core Drill Hole No. 5 (cont'd.)

Distance From Feet	Distance To Feet	Core Recovery Percent	Description
446.6	450.1	92	Dark grey argillite with massive limonite from 448-450 ft. Calcite veins in both argillite and limonite.
450.1	515	80	Dark grey argillite and shale with small quartz veins and occasional limonite veins. Core is approximately 10% quartz. Last 3 ft. has dark brown limonite veins up to 1/2 in. wide.

Hole No. 6

Bearing: S. 83° E. Inclination: 60°

Elevation of collar: 2,612.4 ft. Depth: 483 ft.

Size: AX 0-125 ft; EX 125-483 ft.

Distance From Feet	Distance To Feet	Core Recovery Percent	Description
0	175	80	Dark grey, banded quartzose argillite and slate, numerous bands and lenses of quartz, and quartz veins up to 14 in. wide. Last 15 ft. of core is 20% quartz. Between 81.7-108.7 ft. is considerable rusty limonite, both massive and in 1/4 in. stringers; limonite veins up to 3/8 in. wide in the quartz veins.
175	198	62	Dark grey, fine grained, argillite and slate, with considerable rusty limonite, both massive and in small veins. Much of limonite is vuggy; some sugary quartz and limonite.
198	217	65	Badly broken core. Dark grey argillite and slate, with numerous dark brown to reddish brown stringers and lenses of limonite.
217	220.5	58	Massive dark brown to reddish brown limonite.
220.5	268.5	40	Massive dark brown limonite, dark grey argillite, and light flesh colored quartz; core is 50% limonite, 40% argillite, and 10% quartz.

Log of Diamond Core Drill Hole No. 6 (cont'd)

Distance From Feet	Distance To Feet	Core Recovery Percent	Description
268.5	311.4	58	Dark grey, fine grained, argillite and slate with numerous stringers and lenses of dark brown limonite. From 284 ft. there is considerable light to white colored quartz.
311.4	318.5	65	90% dark brown massive limonite and 10% dark grey argillite and slate.
318.5	322.3	80	Approximately 50% limonite - rest is dark grey argillite. Limonite is in lenses.
322.3	336	10	Reddish brown, massive limonite.
336	390	52	Badly broken core. Dark grey argillite and slate with numerous veins and lenses of dark brown limonite. Last 2 ft. is 50% limonite.
390	391	90	Massive dark brown limonite with 10% argillite.
391	440.1	65	Dark grey, banded argillite and slate with lenses of limonite and considerable amount of white to light grey quartz. At 404.8 ft. - 2 ft. of massive limonite.
440.1	483	90	Abrupt change to a much finer grained light grey, quartzose argillite, at times becoming almost all quartz. Considerable pyrite, particularly in the lighter colored quartzose argillite and in quartz lenses. 6 in. quartz veins at 450 and 455.7 ft. Last 10 ft. of core becoming rusty; hole ends in quartzose argillite and appears to have gone through the mineralized zone appearing on the surface.

Hole No. 7

Bearing: S. 63° W. Inclination: 45°

Elevation of collar: 2,578.9 ft. Depth: 243 ft.

Size: AX 0-73 ft.; EX 73-243 ft.

Distance From Feet	Distance To Feet	Core Recovery Percent	Description
0	24	80	Grey shale and argillite with small quartz veins. At 22.5 ft. is 14 in. of quartz and limonite and a small amount of pyrite. Last 3 in. of core is quartz.
24	42.2	100	Grey shale with bands of quartz or quartzose argillite. Rusty iron stain on joints.
42.2	174.1	41	Dark grey, fine grained argillite and slate with white quartz stringers and veins. At 47.8 ft. core is 80% quartz for 12 in. Slight iron stain on joints.
174.1	177.5	100	Massive dark brown limonite with 10% quartz.
177.5	181.5	0	No core recovery - open fracture or large vug.
181.5	182.9	40	Quartz 60%, dark grey argillite 35%; limonite 5%.
182.9	188.3	37	Massive dark brown to reddish brown limonite with a few vugs and quartz lenses.
188.3	243	35	Broken core. Dark grey argillite and slate banded with quartz. 4 in. quartz vein at 211 ft.; 5 in. quartz vein at 232.6 ft. Massive limonite at 233 - 240.8 ft. End of hole is argillite with rusty joints.

Hole No. 8

Bearing: N. 22° W. Inclination: 45°

Elevation of collar: 2,595.8 ft. Depth: 336 ft.

Size: AX 0-9, EX 9-336

Distance From Feet	Distance To Feet	Core Recovery Percent	Description
0	11	65	Dark grey quartzose argillite and slate.
11	44	42	Light grey quartzose argillite and slate with a few bands of dark grey slate. Small blebs of pyrite in light grey zones. Core is approximately 20% quartz.
44	205.6	25	Broken core. Dark grey quartzose argillite and slate with rusty stain on a few joints. No massive limonite and very little mineralization. A 6 in. quartz vein at 73 feet., and a 5 in. quartz vein at 89.1 ft.
205	256	26	Black, highly carbonaceous shale, and argillite, 12 in. quartz vein at 204.5 ft.
256	336	42	Dark grey quartzose argillite and slate, with a few blebs of pyrite. Considerable quartz. Last foot is black carbonaceous shale. Slight iron stain on joints.

TABLE 1. - Summary of surface sampling data

Sample No.1/	Description	Analyses						
		Cobalt %	Lead %	Zinc %	Copper %	Manganese %	Gold oz./T	Silver oz./T
1	Specimen from trench at Zone 6, massive dark, brown gossan		0.26	0.32	Tr	3.40	Nil	0.35
2	Specimen from trench at Zone 6, dark, brown gossan		Tr	.38	Tr	.15	Nil	.04
3	Specimen from trench at Zone 6, massive crystallized siderite		Tr	.10	Tr	3.40	Nil	.02
4	Gossan from shaft, common over all shear zones		Tr	.30	.10	.36	Nil	Nil
5	Massive, reddish to dark brown gossan, very common		Tr	.32	.10	3.70	Nil	.24
6	Slide rock, limonite and shale		Tr	Tr	Tr	.83	Nil	.08
7	Gossan with quartz and calcite		Tr	.15	.22	.44	Nil	.17
8	Smokey colored quartz vein, 3-4 feet wide		Tr	.05	Tr	.04	Nil	Nil
9	Slate encrusted with a thin coating of cobalt bloom	0.02			.40			

1/ See fig. 3 for location of samples.

TABLE 2. - Summary of diamond core drill sampling data

Sample No. 1/	Hole No.	Sample interval From ft.	Sample interval To ft.	Description	Analyses Pb %	Zn %	Cu %	Mn %	Au %	Ag %
10	1	18.3	18.5	Core, chalcopyrite and pyrite			1.20			
11	1	125.0	128.0	Core, limonite and argillite	Tr	0.05	0.10	1.30	0.01	0.03
12	1	223.1	227.6	Sludge, core was massive limonite	0.12	.18			.02	.17
13	2	260.5	261.5	Core, massive limonite	Tr		Tr		Tr	.28
14	2	261.5	270.5	Core, limonite and argillite	Tr		Tr		Tr	.26
15	2	270.5	278.6	Core, limonite and argillite	Tr		Tr		Tr	.16
16	2	282.5	283.1	Core, argillite and limonite	Tr		Tr		.01	.13
17	2	290.0	290.8	Core, massive limonite	Tr		Tr		.17	.36
18	2	298.2	310.9	Core, altered granite	Tr		Tr		.01	.04
19	3	106.3	110.0	Core, argillite and massive limonite	Tr		Tr		Tr	
20	3	110.9	113.0	Core, massive limonite and argillite	Tr		Tr		Tr	
21	3	118.0	120.0	Core, massive limonite and argillite	Tr		Tr		Tr	
22	3	183.2	183.7	Core, massive limonite and siderite	Tr		Tr		.04	Nil
23	3	242.5	252.6	Core, massive limonite and siderite	Tr		Tr		.01	.03
24	3	252.6	259.8	Core, massive limonite and siderite	Tr		Tr		Tr	.04
25	3	259.8	276.5	Core, massive limonite, siderite and altered granite	Tr		Tr		.01	.01
26	3	360.9	362.4	Core, quartz vein	Tr		Tr		.01	Nil
27	3	390.0	391.5	Core, quartz and argillite	Tr		Tr		Tr	.04
28	4	107.5	110.0	Core, limonite and argillite	Tr		Tr		.01	.25
29	4	140.0	140.5	Core, limonite and siderite	Tr		Tr		Tr	.09
30	4	153.8	160.4	Core, quartz vein	Tr		Tr		Tr	.06
31	4	169.8	174.0	Core, massive limonite	Tr		0.4		.01	.53
32	4	217.8	219.2	Core, massive limonite	Tr		.2		Tr	.04

1/ See figs. 5, 6, 7, and 8 for sample locations.

Table 2. - Summary of diamond core drill sampling data (cont'd)

Sample No. 1/	Hole No.	Sample interval From ft	To ft.	Description	Analyses Pb %	Zn %	Cu %	Mn %	Au %	Ag %
33	5	324.0	339.0	Core, argillite, quartz	Tr		Tr		0.01	Nil
34	5	358.4	359.4	Core, quartz, argillite	Tr		Tr		.01	0.12
35	5	429.3	430.5	Core, massive limonite, calcite stringers, argillite	0.10	0.10	0.30	3.30	.02	.09
36	5	441.8	445.8	Core, massive limonite, calcite stringers, blebs galena	3.00	.10	.10	1.70	.02	.14
37	5	428.0	445.0	Sludge, core had blebs on galena from 441.8 - 445.8 ft.	3.7		Tr		Nil	Nil
38	5	446.2	447.2	Core, massive limonite, argillite, no galena	.07	.10	.20	1.00	.01	.07
39	5	448.5	450.1	Core, massive limonite calcite stringers, no visible galena	.10	Tr	.20	3.10	0.05	0.04
40	5	512.0	514.0	Core, argillite and limonite	Tr		Tr		Tr	.16
41	6	108.0	109.0	Core, limonite, argillite	Tr		Tr		Tr	.13
42	6	175.5	179.5	Core, massive limonite, argillite	Tr		Tr		.01	.34
43	6	183.7	186.1	Core, massive limonite	Tr		Tr		.02	.18
44	6	187.4	194.8	Core, limonite and argillite	Tr		Tr		.01	Nil
45	6	196.2	198.0	Core, massive limonite	Tr		.10	3.90	.03	.01
46	6	214.4	221.0	Core, massive limonite, argillite	Tr		Tr		Tr	.14
47	6	221.0	233.8	Core, limonite, argillite, quartz	Tr		Tr		Tr	.25
48	6	233.8	256.4	Core, limonite, argillite	Tr		Tr		.02	.30
49	6	261.0	271.4	Core, limonite, argillite	Tr		Tr		.04	.01
50	6	292.0	297.5	Core, limonite, argillite, quartz	Tr		Tr		Tr	.05
51	6	301.4	311.4	Core, argillite	Tr		Tr		.01	.07
52	6	311.4	318.0	Core, massive limonite, argillite	Tr		Tr		Tr	.02
53	6	318.0	322.3	Core, limonite, argillite	Tr		Tr		Tr	.06
54	6	322.3	336.0	Core, limonite	Tr		Tr		.01	.10
55	6	336.0	340.3	Core, argillite, limonite	Tr		Tr		Nil	Nil
56	6	340.3	349.7	Core, argillite, limonite	Tr		Tr		Nil	Nil

1/ See figs. 9 and 10 for sample locations.

Table 2. - Summary of diamond core drill sampling data (cont'd)

Sample No. 1/	Hole No.	Sample interval From ft.	To ft.	Description	Analyses Pb %	Zn %	Cu %	Mn %	Au %	Ag %
57	6	353.0	356.3	Core, argillite, limonite	Tr		Tr		Tr	Nil
58	6	356.3	364.2	Core, argillite, limonite	Tr		Tr		.01	.03
59	6	387.5	390.0	Core, argillite, limonite	Tr		Tr		Nil	.02
60	6	390.0	391.5	Core, massive limonite	Tr		Tr		Tr	.03
61	6	414.0	423.0	Core, argillite, limonite & quartz	Tr		Tr		Nil	Nil
62	7	174.1	177.5	Core, massive limonite	Tr		Tr		Nil	Nil
63	7	220.8	225.1	Core, quartz vein	Tr		Tr		Tr	Nil
64	7	233.1	243.0	Core, massive limonite, argillite	Tr		Tr		Nil	Nil
65	8	44.0	57.0	Core, argillite and quartz	Tr		Tr		Nil	Nil
66	8	73.4	73.6	Core, quartz vein	Tr		Tr		Nil	Nil
67	8	205.6	221.0	Sludge, black carbonaceous shale, argillite, quartz veins	Tr		Tr		Tr	.16
68	8	221.0	236.0	Sludge, black carbonaceous shale, argillite	Tr		Tr		Tr	.18
	8	236.0	246.0	Sludge, black carbonaceous shale, argillite					.02	.30
69	8	246.0	256.0	Sludge, black carbonaceous shale, argillite	Tr		Tr		Tr	.26
70	8	256.0	265.1	Core, argillite, quartz, iron stain	Tr		Tr		Tr	Nil
71	8	265.1	265.4	Sludge, quartzose argillite, slate, blebs of pyrite	Tr		Tr		Tr	.16
72	8	305.8	316.4	Core, argillite and quartz	Tr		Tr		Tr	.01

1/ See figs. 10, 11, and 12 for sample locations.