R. I. 4129

November 1947

UNITED STATES
DEPARTMENT OF THE INTERIOR
J. A. Krug, Secretary

BUREAU OF MINES
James Boyd, Director

REPORT OF INVESTIGATIONS

MOUNT ANDREW IRON DEPOSIT, KASAAN PENINSULA, PRINCE OF WALES ISLAND, SOUTHEASTERN ALASKA

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ILLUSTRATIONS

1/ The Bureau of Mines will welcome reprinting of this paper provided the following footnote acknowledgment is used: "Reprinted from Bureau of Mines Report of Investigations 4129."

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3/ Associate mining engineer, Bureau of Mines, Juneau, Alaska.

ILLUSTRATIONS (Continued)

INTRODUCTION

The Mount Andrew iron deposit on Kasaan Peninsula, Prince of Wales Island, Southeastern Alaska, was examined in August 1942 by an engineer4/ of the Bureau of Mines, accompanied by geologists5/ of the Federal Geological Survey. From October 20 to 27, 1942, two engineers6/ of the Bureau of Mines made a further preliminary examination and took three large samples of magnetite and magnetite-copper ore for metallurgical testing. During the summer of 1942 an investigation of the Mount Andrew-Stevenson-Mamie area, including topographic and geologic mapping and a magnetic survey, was made by geologist7/ of the Federal Geological Survey. On May 31 and June 2, 1943, two Bureau of Mines engineers8/ conducted a preliminary examination in which special attention was directed to trails, camp, and drill sites. They were accompanied on May 31 by L. A. Warner of the Geological Survey.

During the period from September 1943 through September 1944 Bureau of Mines engineers9/ completed a thorough investigation which included trenching, core drilling, and sampling. A Federal Geological Survey representative10/ examined all trenches and cores for geological data.

LOCATION AND ACCESSIBILITY

The deposit is situated at latitude 55° 31' N. and longitude 132° 18' W. on the north side of Kasaan Bay on Prince of Wales Island, Southeastern Alaska. The general location is shown on figures 1 and 2. The deposit is 5 miles southeast of the village of Kasaan and, by water, 27 miles northwest of Ketchikan; the main tunnel portal is 7/8 mile north of the Mount Andrew landing on Kasaan Bay.

4/ Thorne, R. L.
5/ Reed, John C., and Goddard, A. N.
6/ Holt, Stephen P., and Thorne, Robert L.
7/ Goddard, A. N., Warner, L. A., and Walton, Matt.
8/ Holt, Stephen P., and Tolonen, A. W.
9/ Wright, Wilford S., Holt, Stephen P., Tolonen, A. W., and Fosse, Earl L.
10/ Bressler, Caldwell T.

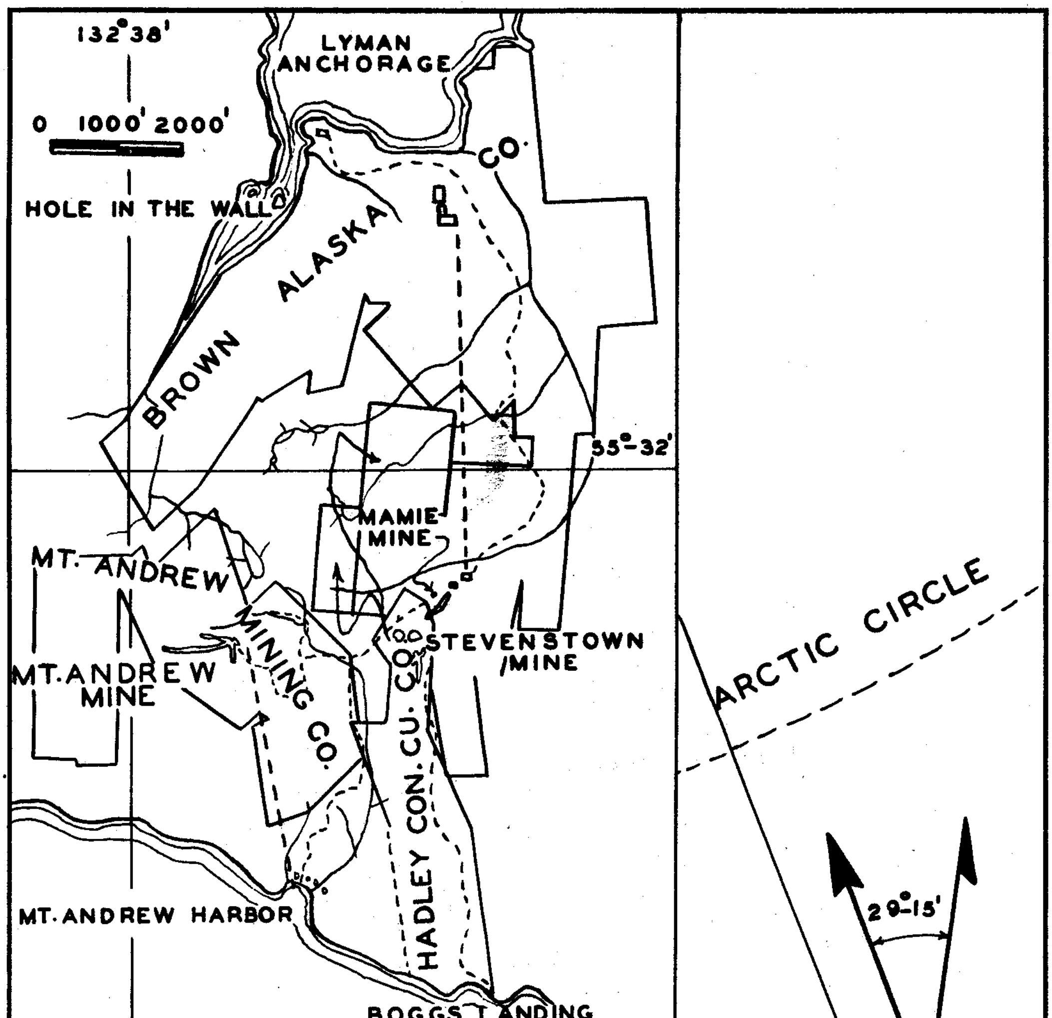


Figure 1. - Index map showing location of Mount Andrew iron deposit.

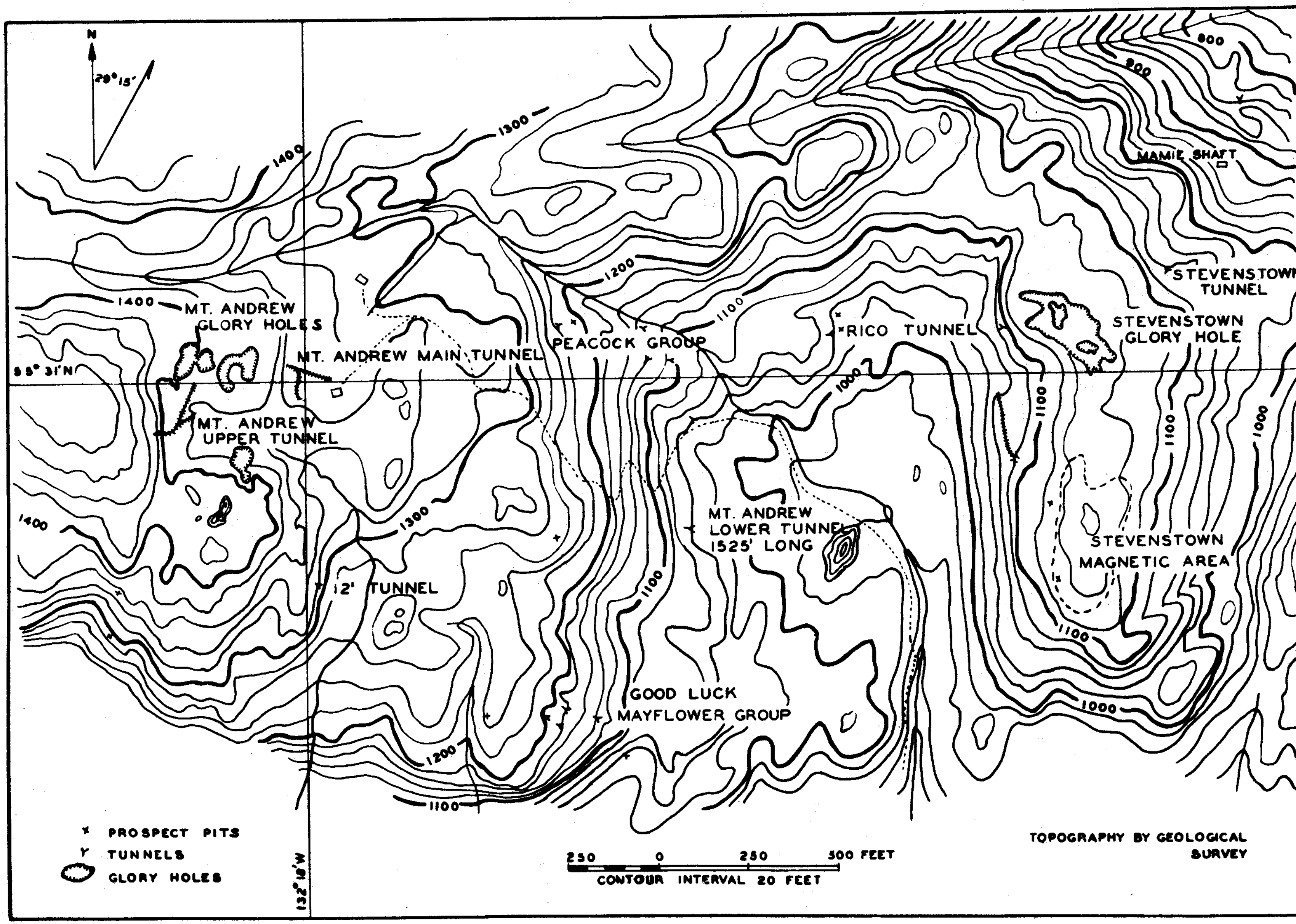


Figure 2. - Topographic map of Mount Andrew - Mamie area.

Kasaan has one store, a post office, an elementary school, and a cannery. Except during the salmon-fishing season in July and August, when the cannery is operating, the community consists of less than 50 persons, mostly native Indians.

Ketchikan, a city of about 6,000 people, is a seaport on the Inside Passage waterway 750 miles north of Seattle and has regular steamer service by the Alaska Steamship Co., Northland Transportation Co., Alaska Transportation Co., Canadian Pacific Railway Co., and the Canadian National Lines.

The ocean freight rate, as quoted by steamship companies, on ore or concentrate from Mount Andrew to points on Puget Sound is $4.50 a ton, plus longshoring charges for loading and unloading. It is reported that marble and limestone were transported in barges from Dall Island to Seattle for $0.90 a ton and that copper ore and concentrates were shipped from Salt Chuck to Tacoma in small motorships for $1.50 a ton. It is believed that a rate of $1.50 a ton, or perhaps less, may be secured for shipload lots.

Ketchikan is the best available source of food and mining supplies, timber, and labor. Regular weekly trips are made from Ketchikan to Kasaan by a motorship which carries mail, passengers, and freight. During the fishing season there is a regular radiophone service from Kasaan to outside points, via Ketchikan.

There are no roads on Kasaan Peninsula. One pack trail was repaired by the Bureau of Mines from Mount Andrew landing to the mine camp. Only blazed markings on trees indicated a route from Mount Andrew landing to the Forest Service trail leading from Lyman Anchorage to Kasaan.

Airplane service from Ketchikan to Kasaan Bay, or return, if previously arranged, is available on regular trips by small seaplanes of the Ellis Airways and Ketchikan Air Service of Ketchikan. The fare is $10.00 a passenger if set off or picked up on a regular trip. Charter trips at greater cost may be arranged.

A fair-weather anchorage for sea-going vessels is located directly offshore from the property. The nearest harbors, safe for small ships during southerly storms, are at Long Island, 1-1/2 miles south of Mount Andrew landing. Safe harbors for larger vessels are at Coal Harbor, or Twelve Mile Arm, across Kasaan Bay.

If the Mount Andrew-Mamie deposits were worked as an independent enterprise it would probably be advisable to have the beach camp at Lyman Anchorage at the abandoned Hadley smelter site on the northeast coast of Kasaan Peninsula. The harbor at this point is sheltered, except on rare occasions when strong northerly winds blow. The beach topography is advantageous for a wharf, mill, and camp sites. Also an aerial tramway, if built to this beach, could serve the Mamie and Stevenstown mines as well as the Mount Andrew mine.

If the Mount Andrew operation were to constitute a unit of a larger enterprise directed by one company to exploit the ore reserves of several deposits on Prince of Wales Island, a site at Kasaan village with its deep-water harbor, ample fresh water, and an established village would doubtless be the most advantageous location for a central mill. This mill site would be midway between the Poor Man and Mount Andrew ore deposits.

PHYSICAL FEATURES AND CLIMATE

The ore deposit lies on the upper slopes and summit of Mount Andrew at an elevation of 1,250 to 1,495 feet. Small streams from a number of small muskegs on top of Mount Andrew join to form a larger stream flowing to the bay near the beach camp. This and the nearby streams are insufficient for milling purposes. At the mine an ample supply of water can be obtained for mining purposes by impounding the mine drainage water, but drinking water must be obtained from another source, such as a small stream outside of camp. Plenty of water for milling purposes is available at Lyman Anchorage.

The climate is typical of southeastern Alaska, with mild temperatures rarely dropping to 0° F. in winter, or rising above 90° F. in summer. Precipitation is heavy, totaling 150 to 159 inches a year, as reported at nearby Ketchikan. Most of the precipitation is in the form of rain; snowfall averages only a few feet a year. During the winter of 1943-44, 4 to 5 feet of snow fell, but at no time were there over 2 feet of snow on the ground. Snowfall may occur any time from October through April, but very seldom is there any snow on the ground after April.

Mining operations can be conducted throughout the year if proper housing is provided. Shipping by vessels along the ice-free Inside Passage continues throughout the year to and from Seattle.

A dense undergrowth is found near sea level. Fine stands of spruce, hemlock, and some yellow cedar would provide ample timber for mining and camp construction.

LABOR AND LIVING CONDITIONS

Under peacetime conditions, labor is reported to have been plentiful and wages reasonable in this area. When this was written (May 1945) skilled labor was scarce, and all wages were high. The hourly wage paid for common labor is $0.965; mechanics, miners, and carpenters receive $1.20 to $1.50 an hour for 40 hours weekly, and time and a half for work over 40 hours. Kasaan, a near-by source of labor, would (except during fishing season) furnish a limited number of native workers, some of whom are skilled carpenters and mechanics.

Because of the mild climate, living conditions are good, although the excessive rainfall is trying for outdoor workmen who are not accustomed to it. Housing facilities at the mine consist of two cabins which are habitable but show prolonged deterioration.

HISTORY AND PRODUCTION

Copper is reported to have been discovered on Kasaan Peninsula by the Russians as early as 1865, but ore bodies were not developed until nearly 40 years later. Mineral locations were made between 1895 and 1900, and deposits were extensively developed during the following 5 years. Mine plants were installed, aerial tramways were erected, and a smelting plant was built at Hadley, a camp on the beach at Lyman Anchorage on the northeast side of Kasaan Peninsula.

In the Mount Andrew area three important mines, the Mount Andrew, Stevenstown, and Mamie, were brought into production by the Mount Andrew Mining Co., the Hadley Copper Co., and the Brown Alaska Co., respectively. Ore was first delivered to the smelter in the latter part of 1905; production was large in 1906 and increased until the smelter was closed in the autumn of 1907. The smelter was again started in 1908 but was operated for a short time only. The Mount Andrew mine was inoperative in 1908 but was placed in production in March 1909 by the Mount Andrew Iron & Copper Co. Ore shipments were made to the Tyee and Tacoma smelters. In 1910, a 1,600-foot adit at an elevation of 1,040 feet was driven to undercut the ore bodies 300 feet below the working levels. Neither copper ores nor magnetite was encountered in the lower adit.

The Mount Andrew mine produced intermittently until the close of World War I, when the collapse of the copper market and the exhaustion of accessible and higher-grade copper deposits caused cessation of operations. The aerial tramway was dismantled, and now all buildings, aside from two rehabilitated by the Bureau of Mines, are in ruins.

According to records, the production of the Mount Andrew-Mamie area has amounted to about 270,000 tons of copper ore, which yielded more than $124,000 in gold and $32,500 in silver.

PROPERTY AND OWNERSHIP

The Mount Andrew Mining Co., a New York corporation, was dissolved pursuant to the laws of New York in April 1940. Titles to its patents and an undivided three-quarters interest were transferred to the stockholders of the estate of H. Herbert Andrew. Participants in the estate receive communications addressed in care of Jarvis Barber & Sons, P. O. Box 20, Sheffield Telegraph Building, High Street, Sheffield, England. An undivided one-quarter interest was transferred to the estate of Samuel Lichtenstadtler, in care of Matthew Stafford, Esq., Dexter Horton Building, Seattle, Wash. The instrument of transfer was dated December 31, 1940.

The holdings consist of the Mount Andrew group of 10 claims, Juneau Survey No. 552, the Rice and Jim, Survey No. 1026, and the Hal, Survey No. 1028, a total of 13 patented claims.

ORE DEPOSITS

General Geology

The principal country rock of the Mount Andrew area is the Kasaan greenstone, which is made up of metamorphosed volcanic flows and pyroclastics, interlayered with siliceous and calcareous sediments. In some parts of the area the greenstone has a very fine-grained, compact structure, resembling that of a massive igneous rock. Presumably this type is igneous in origin and has been greatly altered to an almost homogeneous mass.

The fine-grained material is found to merge graditionally into one in which the clastic texture of quartzites and graywackes may be recognized. Much of the country rock is so altered that its original composition is completely obscured, although it is believed that it consists largely of igneous material worked over mechanically but not perceptibly decomposed. Since deposition, however, it has been greatly changed by shearing, brecciation, and the formation of secondary minerals such as epidote, garnet, hornblende, diopside, chlorite, orthoclase, magnetite, chalcopyrite, and pyrite.

Limestones and conglomerates are found interbedded with the graywackes and quartzites in other parts of the greenstone matrix. The limestones, though warped, folded, and recrystallized, are easily recognized. The layers, seldom continuous for any great distance, thin, thicken, or play out abruptly.

Early regional metamorphism of the formations comprising the greenstone may have been caused by the pressure of overlying strata, but more-pronounced alteration was undoubtedly brought about by later invasion of a granitic intrusive produced much folding, fracturing and metamorphism near the contact of the intrusive and invaded rocks. During stages of cooling, fissures and cracks formed near the contact and offered channels for later magmatic injections which are represented by the numberous igneous dikes as shown in figure 3. These later intrusives increased the degree of metamorphism along their contacts with the greenstone, evidence of which is found in the abundance of secondary minerals. Thus the entire Mount Andrew area consists of an altered greenstone lying at the contact of a granitic intrusive and between nearly vertical porphyritic dikes.

Occurrence of Deposits

The ore bodies are replacement deposits of the contact metamorphic type and occur as irregular lenses between the intrusive rocks. Magnetite is found in all degrees of abundance from sparsely disseminated mineral particles in greenstone to the massive state. Pyrite and chalcopyrite are usually found disseminated in the magnetite, although at places in the contact zone, chalcopyrite occurs in sufficient abundance to be mined as copper ore. Much of the copper ore has already been mined.

Joint cracks and faults of slight displacement within the mineralized area undoubtedly developed after the period of ore deposition. In a few places these breaks have developed to the extent that the use of timbers would probably be required in mining.

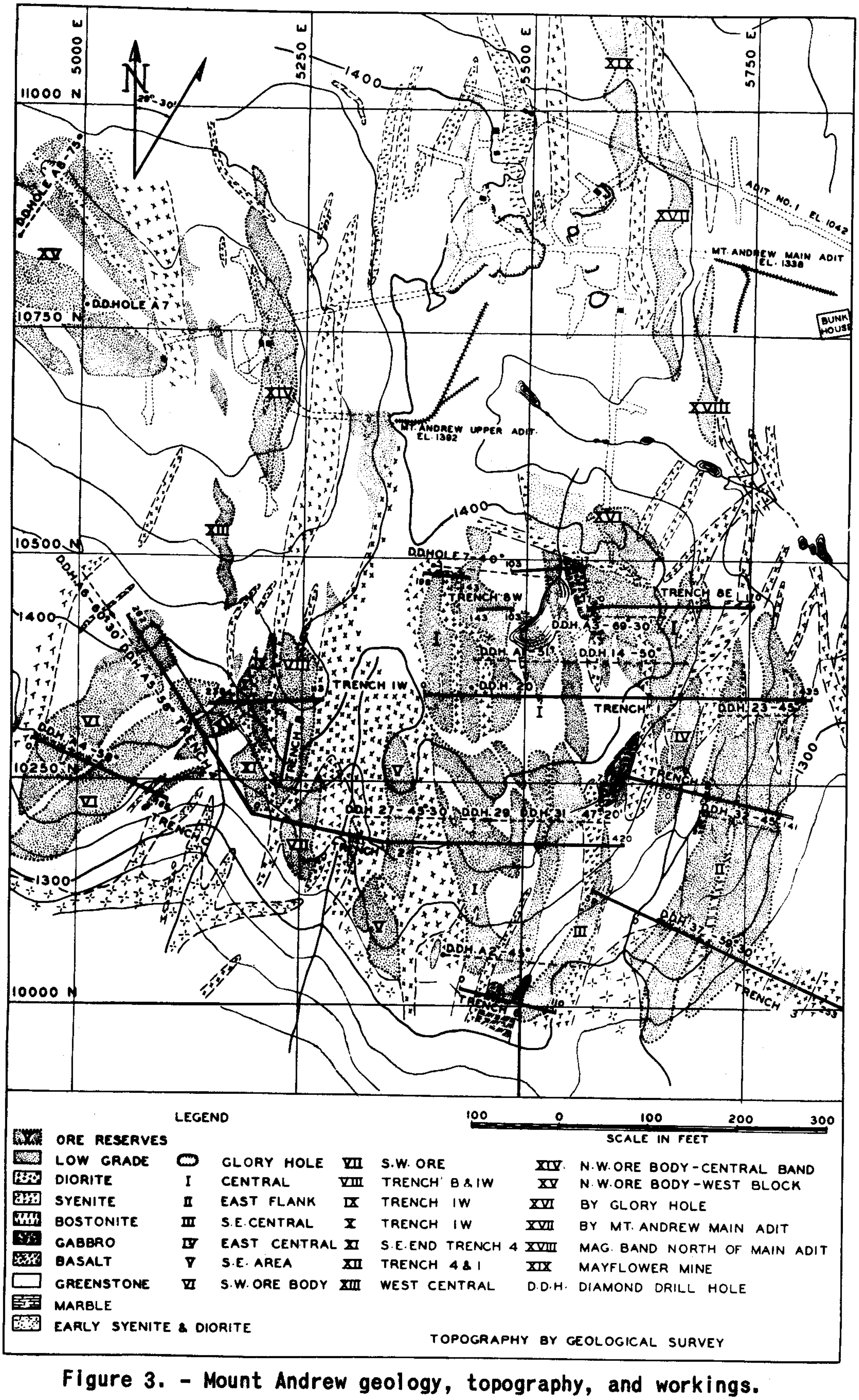


Figure 3. - Mount Andrew geology, topography, and workings.

The Mount Andrew ore zone has a general north-south trend and covers an area roughly 1,000 feet long by 850 feet wide. The ore bodies, for reference purposes, are named and numbered as shown on figure 3.

Ore lenses are folded, widened, and thinned, where dragged on faults, or cut off abruptly. Lens thicknesses range from 3 to 100 feet and lengths from 50 to 400 feet.

The larger lenses of magnetite to the south have a combined thickness of 100 to 150 feet and occur within a syncline about 500 feet wide by 600 feet long. Magnetite outcrops are found in the south area and around the Mount Andrew mine workings, but on the west flank of the ore zone a large deposit was encountered in drilling 45 to 115 feet below the surface. The structure is contorted by a series of small folds and faults and is flanked on the east and west by sharp anticlines. Along the west flank of the west anticline lie ore bodies which were partly explored by core drilling by the Bureau of Mines in the summer of 1944. Moderately high positive magnetic anomalies outside the drilled area indicate the presence of unexplored ore lenses. Areas in which the dip needle map shows positive readings of more than 20°, have possible ore reserves at depths of 200 to 300 feet. There are also small magnetite outcrops.

Other ore bodies considered are the Mayflower group, ore remnants around Mount Andrew main workings, a lens of ore outcropping at the portal of the main tunnel, and magnetically indicated ore bodies and outcrops lying northeast of the main workings.

Magnetite deposits that could be worked in conjunction with the Mount Andrew ore bodies include the Mamie and Stevenstown, the location of which are shown in figure 2.

TRENCHING AND CORE DRILLING

Trench Sampling

During the period November 1943 through January 1944 and during the drilling program of 1944, nine trenches were dug and the exposed magnetite was sampled. Underground and check sampling was also done, all of which is summarized in table 1.

A total of 2,476 feet of trench was excavated in preparation for sampling. Results of channel sampling and logs of exposed material are summarized in table 2.

TABLE 1. - Number and combined lengths of trench samples

Location	No. of original samples	No. of check samples	Total	Sampled length, feet	Type of sample
Trench 1 East	25	13	38	226.5	Channel
Trench 1 West	10	0	10	86.0	Do.
Trench 2 East	22	5	27	194.0	Do.
Trench 3 E. & W.	14	0	14	101.0	Do.
Trench 4 West	15	0	15	135.0	Do.
Trench 6	4	3	7	38.0	Do.
Trench 8 East	10	6	16	80.0	Do.
Trench 8 West	11	0	11	90.0	Do.
Trench 9	11	2	13	103.5	Do.
Trench B	8	0	8	80.0	Do.
Trench C	11	0	11	95.5	Do.
South drift	6	0	6	44.8	Do.
Cliff drift	4	0	4	17.0	Do.
Total	151	29	180	1,291.3	

TABLE 2. - Trench-sample results

Trench 1 East

Station 0 at coordinate 10347N. and 5387E.; bearing, east, length, 435 feet

Footage		Feet	Percent		Formation
From	To		Fe	Cu	
0	18	18	46.4	0.16	Magnetite
18	21	3	-	-	Greenstone
21	31	10	51.6	.05	Magnetite
31	41	10	-	-	Diorite
41	58	17	53.2	.42	Magnetite
58	77	19	-	-	Diorite
77	107	30	51.8	.35	Magnetite
107	126	19	-	-	Greenstone
126	131	5	42.8	.22	Magnetite
131	155	24	-	-	Greenstone
155	176	21	58.8	.24	Magnetite
176	251	75	-	-	Greenstone
251	255	4	-	-	Syenite
255	280	25	39.6	.13	Magnetite
280	289.5	9.5	-	-	Bostonite
289.5	306	16.5	56.1	.13	Magnetite
306	333	27	-	-	Syenite
333	355	22	36.4	.04	Mag. & gr.
355	361	6	-	-	Diorite
361	377	16	-	-	Greenstone
377	407	30	55.5	.01	Magnetite
407	416	9	-	-	Greenstone
416	423	7	60.6	.05	Magnetite
423	432	9	-	-	Greenstone
432	435	3	-	-	Magnetite

Trench 1 West

Station 0 at coordinate 10346N. and 5386E.; bearing, west; length, 238 feet

Footage		Feet	Percent		Formation
From	To		Fe	Cu	
0	124	124	-	-	Diorite
124	166	42	46.6	0.26	Magnetite
166	178	12	-	-	Diorite
178	192	14	47.4	.77	Magnetite
192	198	6	-	-	Diorite
198	208	10	53.4	.59	Magnetite
208	214	6	-	-	Diorite
214	228	14	57.4	.38	Magnetite
228	238	10	-	-	Greenstone

Trench 2

Station 0 at coordinates 10213N. and 5196E.; bearing, S. 79° E.; 148 feet, thence east 272 feet

Footage		Feet	Percent		Formation
From	To		Fe	Cu	
0	23	23	-	-	Greenstone
23	35	12	-	-	Diorite
35	71	36	59.3	0.09	Magnetite
71	112	41	-	-	Syenite
112	122	10	56.6	.02	Magnetite
122	154	32	-	-	Diorite
154	182	28	47.7	.12	Magnetite
182	222	40	-	-	Diorite
222	313	91	44.5	.03	Magnetite
313	321	8	-	-	Greenstone
321	330	9	61.4	.02	Magnetite
330	334	4	-	-	Diorite
334	344	10	59.2	.11	Magnetite
344	354	10	24.8	.04	Mag. & gr.
354	376	22	-	-	Greenstone
376	396	20	-	-	Basalt
396	401	5	58.0	.13	Magnetite
401	420	19	-	-	Greenstone

Trench 3

Station 0 at coordinates 10109N., bearing, S. 66° E., length 253 feet; 5631E., bearing, N. 66° W., length 59 feet

Footage			Percent		
From	To	Feet	Fe	Cu	Formation
59 W.	51 W.	8	58.6	0.11	Magnetite
51 W.	47 W.	4	-	-	Greenstone
47 W.	42 W.	5	56.2	.09	Magnetite
42 W.	37 W.	5	-	-	Diorite-syenite
37 W.	25 E.	62	-	-	Greenstone
25 E.	39 E.	14	54.7	.05	Magnetite
39 E.	48 E.	9	-	-	Greenstone
48 E.	74 E.	26	64.7	.07	Magnetite
74 E.	84 E.	10	-	-	Bostonite
84 E.	131 E.	47	56.6	.07	Magnetite
131 E.	134 E.	3	-	-	Gr. & mag.
134 E.	162 E.	28	-	-	Syenite
162 E.	188 E.	26	-	-	Diorite
188 E.	192 E.	4	51.9	.07	Magnetite
192 E.	195 E.	3	-	-	Mag. & gr.
195 E.	213 E.	18	-	-	Diorite
213 E.	253 E.	40	-	-	Syenite

Trench 4

Station 0 at coordinates 10213N. and 5196E.; bearing, N. 32° 30' E.; length, 262 feet

Footage			Percent		
From	To	Feet	Fe	Cu	Formation
0	8	8	49.9	0.05	Magnetite
8	99	91	-	-	Greenstone
99	123	24	56.2	.06	Magnetite
123	130	7	-	-	Greenstone
130	168	38	48.5	.05	Magnetite
168	187	19	-	-	Greenstone
187	234	47	56.7	.18	Magnetite
234	254	20	22.5	.18	Mag. & gr.
254	264	10	-	-	Greenstone

Trench 6

Station 0 at coordinates 10018N. and 5432 E.; bearing, S. 77° 30' E.; length, 110 feet

Footage			Percent		
From	To	Feet	Fe	Cu	Formation
0	18	18	-	-	Greenstone
18	30	12	-	-	Syenite
30	50	20	-	-	Gabbro
50	60	10	58.9	0.08	Magnetite
60	72	12	-	-	Gabbro
72	100	28	56.3	.05	Magnetite
100	110	10	-	-	Syenite

Trench 8

Station 0 at coordinates 10448N. and 5586E.; bearing, E. 170'; W. 0 - 17' (offset 45' N.) 17 - 103' (offset 42' S.) 103 - 143'; (offset 34' N.) 143 - 198'; length, 381 feet

Footage			Percent		
From	To	Feet	Fe	Cu	Formation
211 W.	184 W.	27	-	-	Syenite
184 W.	174 W.	10	58.9	0.09	Magnetite
174 W.	162 W.	12	-	-	Diorite
162 W.	158 W.	4	64.8	.09	Magnetite
158 W.	153 W.	5	-	-	Diorite
153 W.	103 W.	50	47.0	.12	Magnetite
103 W.	63 W.	40	-	-	Greenstone
63 W.	47 W.	16	59.5	.91	Magnetite
47 W.	42 W.	5	-	-	Greenstone
42 W.	10 W.	32	-	-	Gabbro
10 W.	70 E.	80	55.7	.07	Magnetite
70 E.	84 E.	14	-	-	Diorite
84 E.	96 E.	12	62.0	.22	Magnetite
96 E.	111 E.	15	-	-	Greenstone
111 E.	119 E.	8	39.4	.19	Magnetite
119 E.	135 E.	16	-	-	Greenstone
135 E.	170 E.	35	-	-	Bostonite

Trench 9

Station 0 at coordinate 10244N., bearing, 0 - 141'E., S. 77° E., 5675E., bearing, 0 - 73'W.; N. 77° W., length, 217 feet

Footage			Percent		
From	To	Feet	Fe	Cu	Formation
73 W.	66 W.	7	-	-	Gabbro
66 W.	61 W.	5	-	-	Mag. & gr.
61 W.	50 W.	11	-	-	Gabbro
50 W.	47 W.	3	-	-	Mag. & gr.
47 W.	15 W.	32	-	-	Syenite
15 W.	10 W.	5	-	-	Greenstone
10 W.	1.5 W.	8.5	56.9	0.14	Magnetite
1.5 W.	0.0	1.5	-	-	Greenstone
0.0	11 E.	11	62.3	.13	Magnetite
11 E.	26 E.	15	-	-	Greenstone
26 E.	29 E.	3	-	-	Magnetite
29 E.	39 E.	10	-	-	Greenstone
39 E.	75 E.	36	62.9	.05	Magnetite
75 E.	78 E.	3	-	-	Greenstone
78 E.	126 E.	48	57.4	.09	Magnetite
126 E.	144 E.	18	-	-	Gr. & slide rock

Trench "B"

Station 0 at coordinate 5231 E., 0 to 80, bearing, S. 11° W., 10326 N., length, 80 feet

Footage			Percent		
From	To	Feet	Fe	Cu	Formation
0	80	80	45.7	0.18	Magnetite

Trench "C"

Station 0 at coordinates 10295 N. and 4948 E.; bearing, S. 23° 30' E.; length, 165 feet

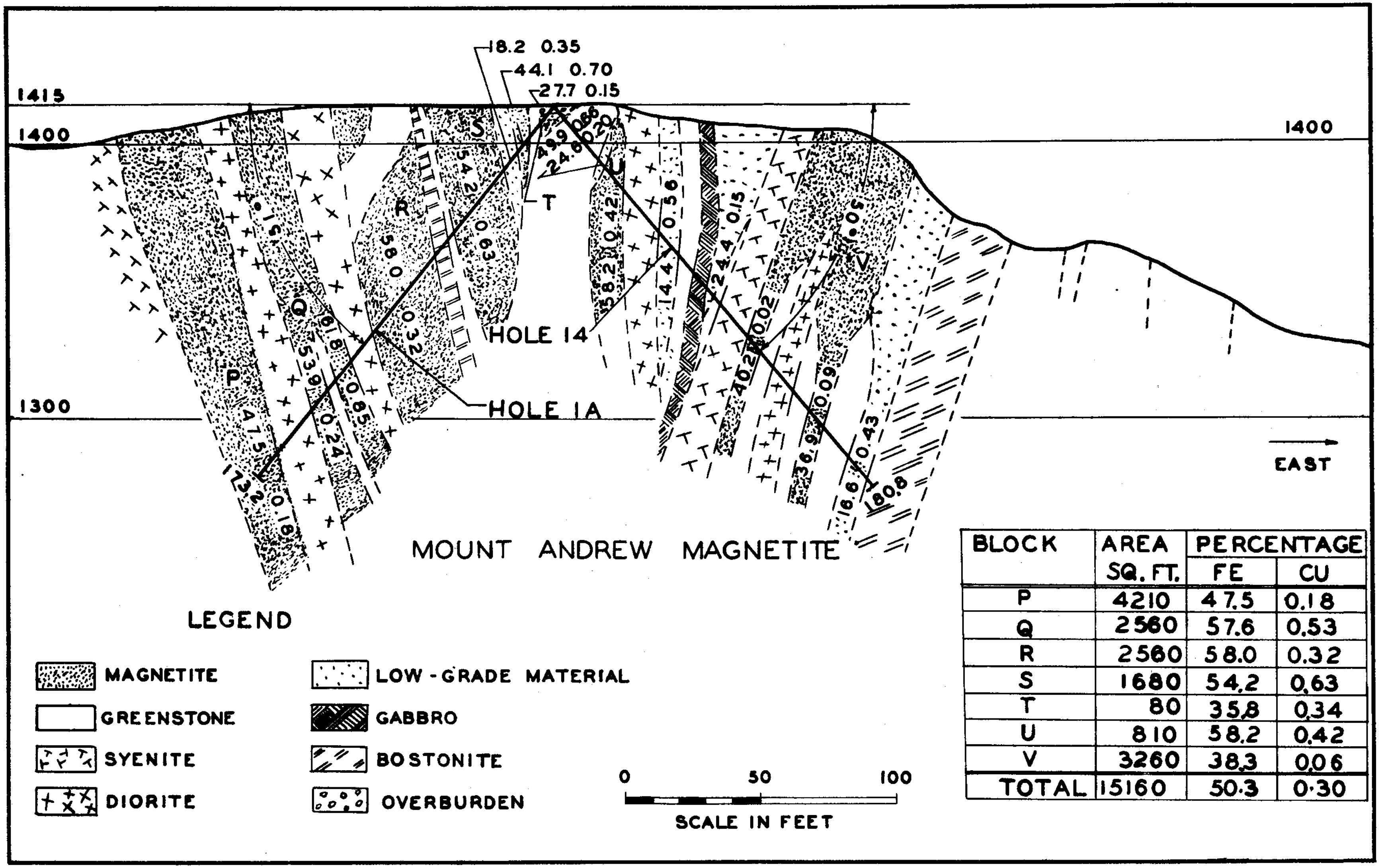
Footage			Percent		
From	To	Feet	Fe	Cu	Formation
0	6	6	-	-	Syenite
6	39	33	26.9	0.06	Gr. & mag.
39	47.5	8.5	-	-	Greenstone
47.5	70	22.5	45.7	.09	Magnetite
70	78.5	8.5	-	-	Greenstone
78.5	126	47.5	52.9	.04	Magnetite
126	141	15	-	-	Greenstone
141	146	5	-	-	Syenite
146	152	6	-	-	Greenstone
152	155	3	-	-	Magnetite
155	165	10	-	-	Greenstone

Core and Sludge Sampling

Between March and September 1944 the Bureau of Mines completed 17 core-drill holes to depths of 115 to 270 feet, aggregating 3,217.5 feet. The drill frequently encountered "fracture" zones and cavities in the rock which resulted in the loss of drilling water, caved holes, excessive bit wear, and slow advance.

The samples were analyzed by the Territorial Assay Office, Ketchikan, Alaska, and Smith-Emery Co., Los Angeles, Calif. 576 core and sludge samples were submitted, all of which were analyzed for iron and copper. The iron content of sludge samples was generally found to be higher than that of corresponding core samples.

In parts of the drill holes where the core recovery was 90 percent or greater, sludge analyses were disregarded, and the core analyses were accepted as representative of the ore. If the core recovery was less than 90 percent, a weighted average was made of the core and sludge analyses in accordance with the ratios given in the Longyear table. Core and sludge analyses, and core logs are summarized in table 3. The location of drill holes and trenches are shown in figure 3, and sections on lines of holes with average sample analyses are shown on figures 4 to 15 inclusive.



BLOCK	AREA SQ. FT.	PERCENTAGE FE	PERCENTAGE CU
P	4210	47.5	0.18
Q	2560	57.6	0.53
R	2560	58.0	0.32
S	1680	54.2	0.63
T	80	35.8	0.34
U	810	58.2	0.42
V	3260	38.3	0.06
TOTAL	15160	50.3	0.30

Figure 4. - Section of ore body I, drill holes A1 and 14.

ORE BODY	BLOCK	AREA SQ. FT.	PERCENTAGE	
			FE	CU
I	36.0 - 77.5	2240	52.9	0.04
III	180.0 - 208.0	2700	35.6	0.03
V		500		

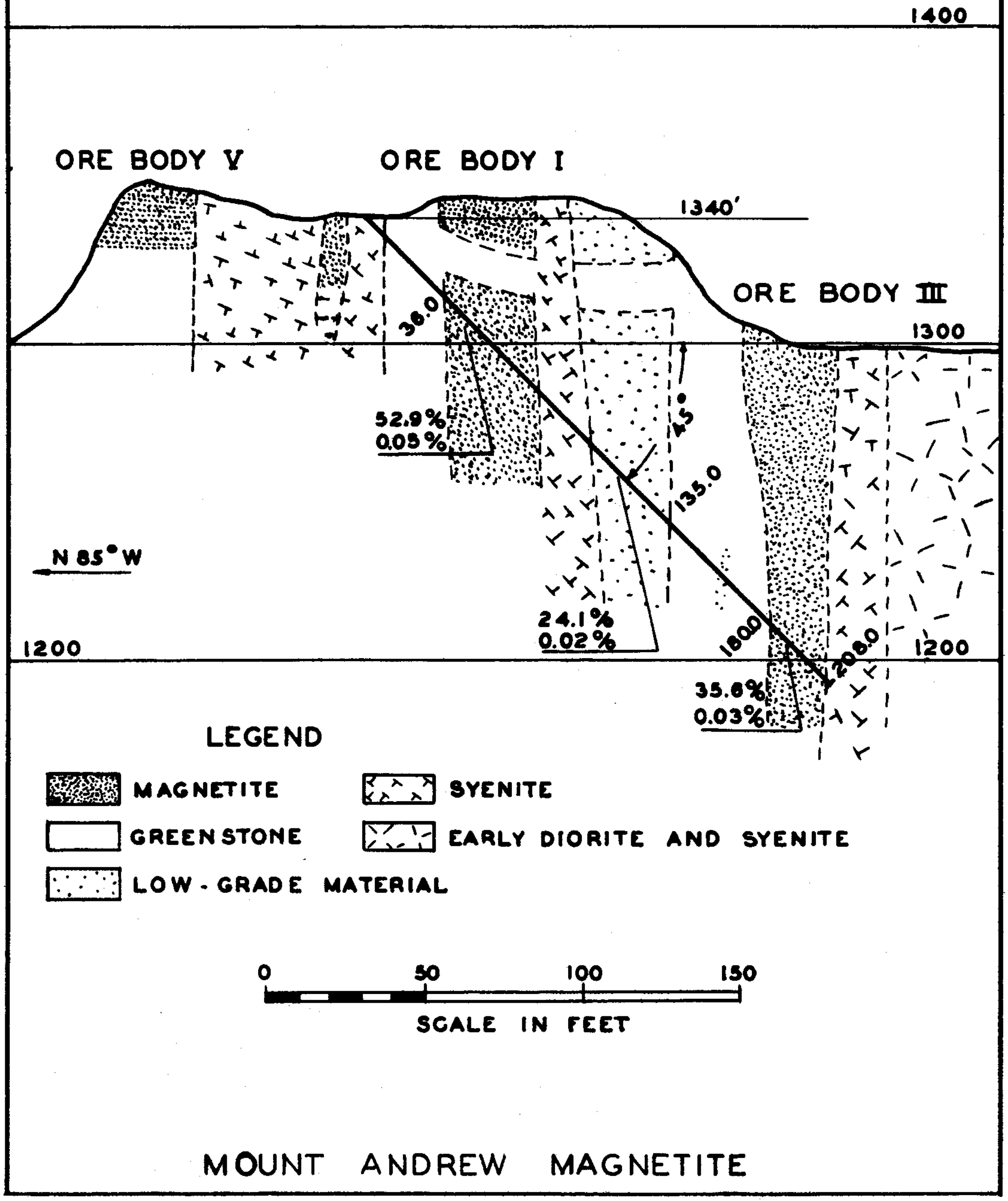


Figure 5. - Section of ore bodies V, I, and III, drill hole A2.

TABLE 3. - Drill-hole sample results

Hole A1 (fig. 4)

Project 927; Mount Andrew, Alaska; dip, -51°; length, 173.2'; coordinates, 10389.5 N., 5545.0 E.; elev., 1,415 feet; bearing, W.; dates drilled, April 8-18, 1944

Footage			Percent		
From	To	Feet	Fe	Cu	Formation
0.0	2.5	2.5	-	-	Overburden
2.5	7.7	5.2	27.7	0.15	Mag. & gr.
7.7	14.5	6.8	-	-	Greenstone
14.5	19.0	4.5	44.1	.70	Magnetite
19.0	29.5	10.5	18.2	.35	Gr. & mag.
29.5	60.2	30.7	54.2	.63	Magnetite
60.2	63.0	2.8	-	-	Greenstone
63.0	69.0	6.0	-	-	Bostonite
69.0	105.8	36.8	58.0	.32	Magnetite
105.8	121.5	15.7	-	-	Diorite
121.5	128.8	7.3	61.8	.85	Magnetite
128.8	133.8	5.0	-	-	Greenstone
133.8	142.0	8.2	53.9	.24	Magnetite
142.0	162.0	20.0	-	-	Diorite
162.0	173.2	11.2	47.5	.18	Magnetite

Hole A2 (fig. 5)

Project 927; Mount Andrew, Alaska; dip, -45°; length, 208.0'; coordinates, 10058.0 N., 5417.0 E.; elev., 1,340 feet; bearing, S. 85° E.; dates drilled, June 6-16, 1944

Footage			Percent		
From	To	Feet	Fe	Cu	Formation
0.0	8.0	8.0	-	-	Syenite & gr.
8.0	13.5	5.5	-	-	Greenstone
13.5	15.0	1.5	53.6	0.20	Magnetite
15.0	36.0	21.0	-	-	Greenstone
36.0	77.5	41.5	52.9	.05	Magnetite
77.5	101.1	23.6	-	-	Diorite
101.1	135.0	33.9	24.1	.02	Mag. & gr.
135.0	159.0	24.0	-	-	Greenstone
159.0	161.0	2.0	27.3	.02	Gr. & mag.
161.0	180.0	19.0	-	-	Greenstone
180.0	204.5	24.5	35.6	.03	Mag. & gr.
204.5	208.0	3.5	-	-	Syenite

Hole A3 (fig. 6)

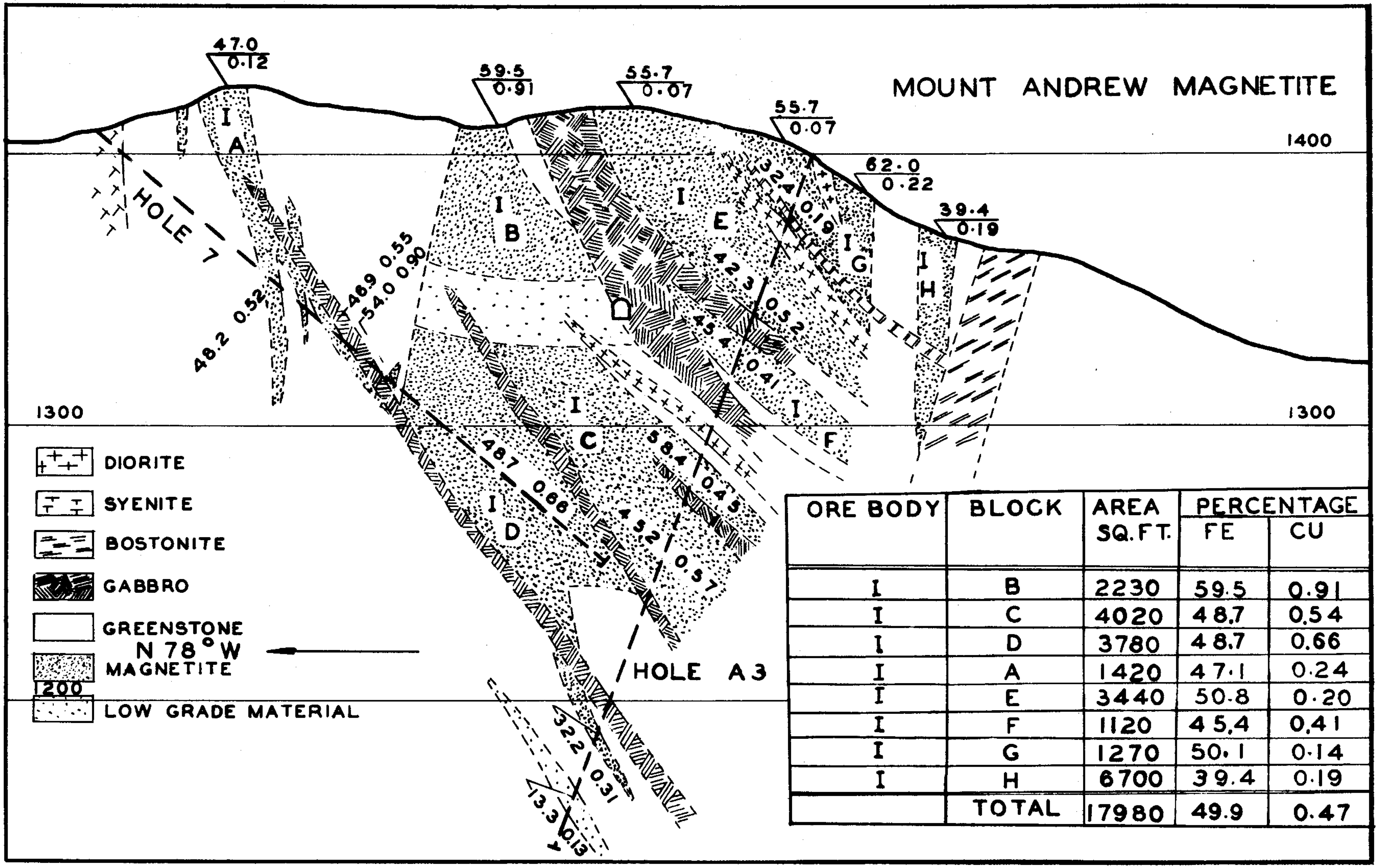
Project 927; Mount Andrew, Alaska; dip, -69° 30'; length, 270.0'; coordinates, 10441.0 N. 5654.5 E.; bearing, west; elev., 1,398.0'; dates drilled, July 5-18, 1944

Footage			Percent		
From	To	Feet	Fe	Cu	Formation
0.0	5.5	5.5	-	-	Overburden
5.5	23.0	17.5	32.4	0.19	Mag. & gr.
23.0	31.1	8.1	-	-	Bostonite
31.1	60.0	28.9	42.3	.52	Mag. & gr.
60.0	69.0	9.0	-	-	Gabbro
69.0	85.0	16.0	45.4	.41	Mag. & gr.
85.0	115.8	30.8	-	-	Gabbro & gr.
115.8	129.0	13.2	58.4	.45	Magnetite
129.0	133.2	4.2	-	-	Gabbro
133.2	169.7	36.5	45.2	.57	Magnetite
169.7	175.0	5.3	-	-	Gabbro
175.0	221.7	46.7	-	-	Greenstone
221.7	228.5	6.8	32.2	.31	Gr. & mag.
228.5	247.7	19.2	-	-	Greenstone
247.7	250.0	2.3	20.8	.20	Gr. & mag.
250.0	252.2	2.2	-	-	Greenstone
252.2	255.0	2.8	17.5	.18	Gr. & mag.
255.0	269.2	14.2	-	-	Greenstone
269.2	270.0	.8	-	-	Gouge

Hole A4 (fig. 7)

Project 927; Mount Andrew, Alaska; dip, -58°; length, 160.0'; coordinates, 10299.5 N., 4952.5 E.; bearing, S. 67° E.; elev., 1,376'; dates drilled, July 29 - August 7, 1944

Footage			Percent		
From	To	Feet	Fe	Cu	Formation
0.0	2.0	2.0	-	-	Overburden
2.0	12.0	10.0	-	-	Syenite
12.0	40.0	28.0	52.8	0.22	Magnetite
40.0	48.3	8.3	-	-	Greenstone
48.3	60.0	11.7	18.3	.06	Gr. & mag.
60.0	85.8	25.8	29.5	.13	Mag. & gr.
85.8	93.8	8.0	-	-	Greenstone
93.8	97.2	3.4	37.0	.09	Mag. & gr.
	97.0 fault				
97.2	125.0	27.8	-	-	Greenstone
125.0	160.0	35.0	-	-	Do.



ORE BODY	BLOCK	AREA SQ.FT.	PERCENTAGE FE	CU
I	B	2230	59.5	0.91
I	C	4020	48.7	0.54
I	D	3780	48.7	0.66
I	A	1420	47.1	0.24
I	E	3440	50.8	0.20
I	F	1120	45.4	0.41
I	G	1270	50.1	0.14
I	H	6700	39.4	0.19
	TOTAL	17980	49.9	0.47

Figure 6. - Section of ore body I, drill holes A3 and 7.

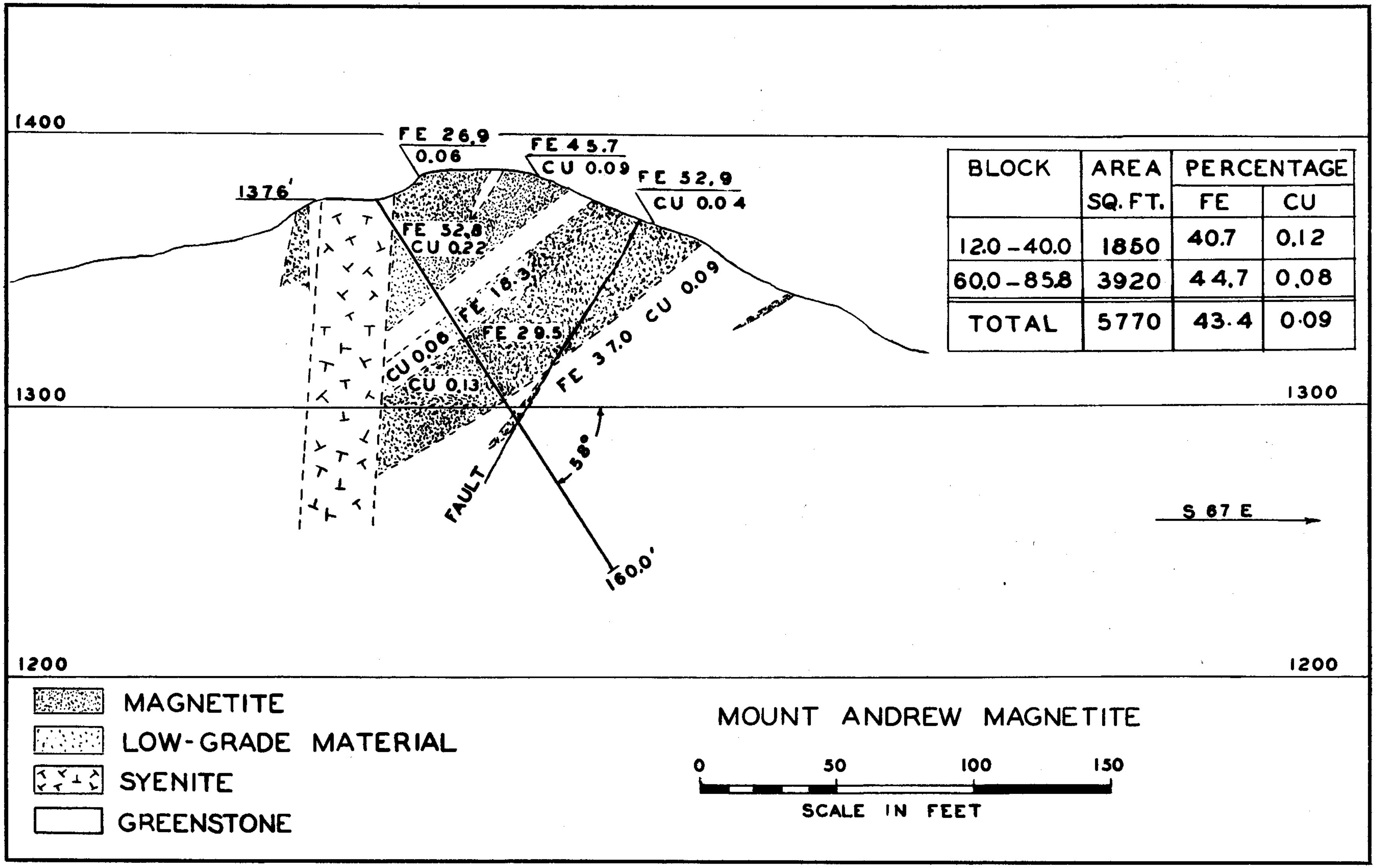
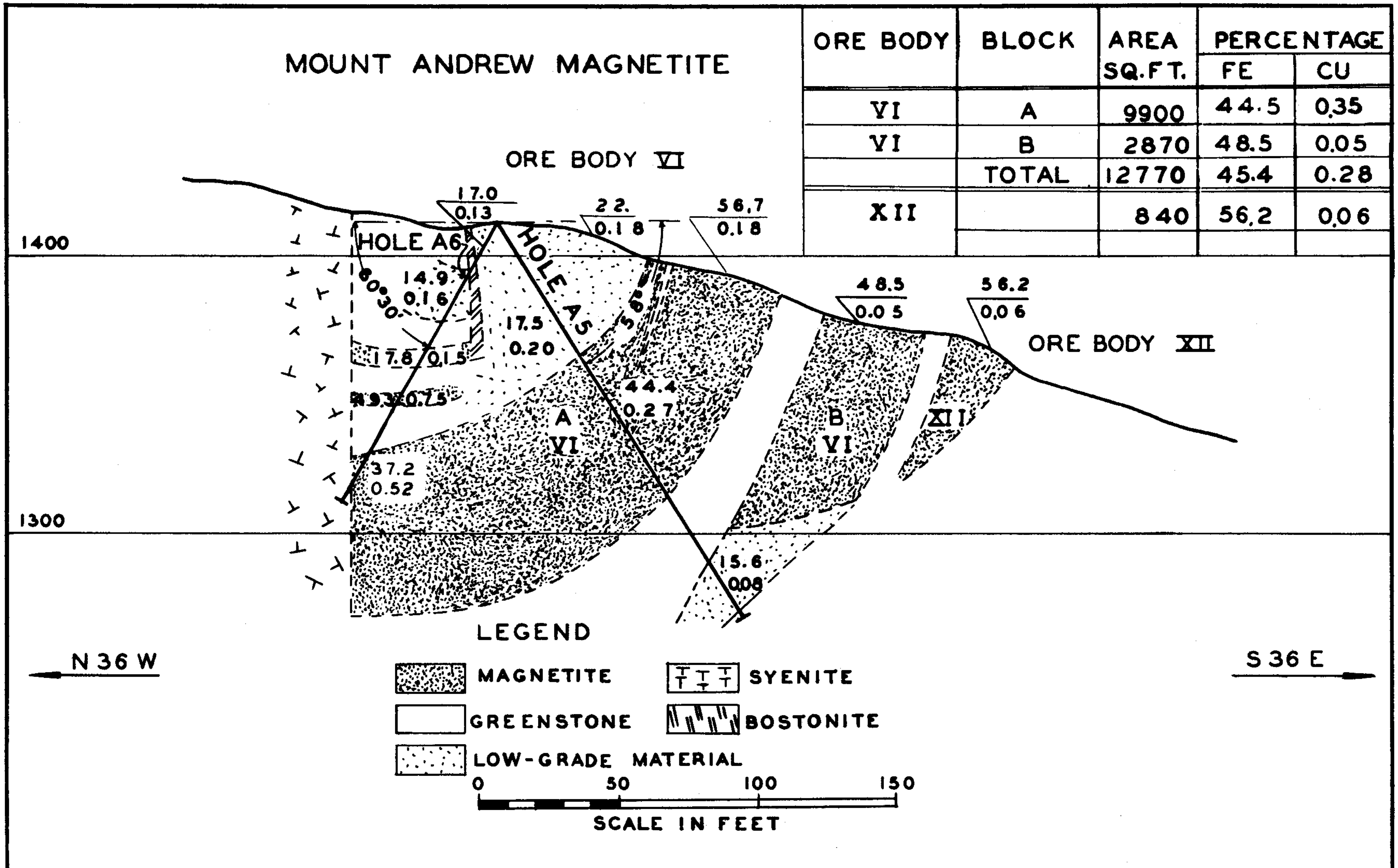


Figure 7. - Section of ore body VI, drill hole A4, trench C.



ORE BODY	BLOCK	AREA SQ.FT.	PERCENTAGE FE	PERCENTAGE CU
VI	A	9900	44.5	0.35
VI	B	2870	48.5	0.05
	TOTAL	12770	45.4	0.28
XII		840	56.2	0.06

Figure 8. - Section of ore body VI, drill holes A5 and A6, trench 4.

Hole A5 (fig. 8)

Project 927; Mount Andrew, Alaska; dip, -58°; length, 166.0'; coordinates, 10434.5 N., 5037.5 E.; bearing, S. 36° E.; elev., 1,413'; dates drilled, August 8 - 15, 1944

Footage			Percent		
From	To	Feet	Fe	Cu	Formation
0.0	2.0	2.0	-	-	Overburden
2.0	9.0	7.0	-	-	Greenstone
9.0	10.0	1.0	-	-	Bostonite
10.0	16.5	6.5	-	-	Greenstone
16.5	55.0	38.5	17.5	0.20	Gr. & mag.
55.0	116.7	61.7	44.4	.27	Magnetite
116.7	145.0	28.3	-	-	Greenstone
145.0	164.0	19.0	15.6	.08	Gr. & mag.
164.0	164.5	.5	-	-	Bostonite
164.5	166.0	1.5	-	-	Greenstone - some bostonite

Hole A6 (fig. 8)

Project 927; Mount Andrew, Alaska; dip, -60-1/2°; length, 114.5'; coordinates, 10434.5 N., 5037.6 E.; bearing, N. 36° W.; elev., 1,413'; dates drilled, August 15-18, 1944

Footage			Percent		
From	To	Feet	Fe	Cu	Formation
0.0	2.0	2.0	-	-	Overburden
2.0	16.0	14.0	17.0	0.13	Gr. & mag.
16.0	20.3	4.3	-	-	Bostonite
20.3	40.5	20.2	14.9	.16	Gr. & mag.
40.5	52.0	11.5	-	-	Greenstone
52.0	60.0	8.0	17.8	.15	Gr. & mag.
60.0	73.0	13.0	-	-	Greenstone
73.0	76.5	3.5	49.3	.75	Mag. & gr.
76.5	79.2	2.7	12.1	.07	Do.
79.2	96.0	16.8	-	-	Greenstone
96.0	107.0	11.0	40.1	.65	Mag. & gr.
107.0	110.3	3.3	27.6	.07	Do.
110.3	114.5	4.2	-	-	Syenite

Hole A7 (fig. 9)

Project 927; Mount Andrew, Alaska; dip, -90°; length, 195.0'; coordinates, 10779.3 N., 5007.5 E.; bearing--; elev. 1,489.0'; dates drilled, August 19 - 26, 1944

Footage			Percent		
From	To	Feet	Fe	Cu	Formation
0.0	9.0	9.0	10.5	0.10	Gr. & mag.
9.0	20.0	11.0	-	-	Greenstone
20.0	23.0	3.0	13.0	.19	Gr. & mag.
23.0	30.5	7.5	-	-	Greenstone
30.5	45.5	15.0	15.5	.12	Gr. & mag.
45.5	75.5	29.5	-	-	Greenstone
75.0	80.0	5.0	28.0	1.40	Gr. & mag.
80.0	90.0	10.0	-	-	Greenstone
90.0	120.0	30.0	17.8	.56	Gr. & mag.
120.0	131.5	11.5	42.4	1.37	Magnetite
131.5	140.0	8.5	15.9	.26	Gr. & mag.
140.0	183.0	43.0	42.6	.88	Magnetite
183.0	195.0	12.0	10.6	.18	Gr. & mag.

Hole A8 (fig. 9)

Project 927; Mount Andrew, Alaska; dip, -75°; length, 179.0'; coordinates, 10852.1 N., 4931.0 E.; bearing, N. 35° - 18' E.; elev., 1,492.0'; date drilled, August 27, September 1, 1944

Footage			Percent		
From	To	Feet	Fe	Cu	Formation
0.0	30.0	30.0	-	-	Greenstone
30.0	61.0	31.0	17.1	0.37	Gr. & mag.
61.0	70.5	9.5	36.8	1.67	Magnetite
70.5	74.4	3.9	-	-	Greenstone
74.4	120.0	45.6	43.2	1.14	Magnetite
120.0	145.0	25.0	-	-	Greenstone
145.0	175.0	30.0	35.0	.33	Mag. & gr.
175.0	179.0	4.0	-	-	Greenstone

Hole 7 (fig. 6)

Project 927; Mount Andrew, Alaska; dip, -40°; length, 242.7' coordinates, 10495.0 N., 5396.0 E.; bearing, S. 85° E.; elev., 1,408'; date drilled, April 19 - May 1, 1944

Footage			Percent		
From	To	Feet	Fe	Cu	Formation
0.0	8.5	8.5	-	-	Syenite
8.5	11.0	2.5	-	-	Diorite
11.0	77.0	66.0	-	-	Greenstone
77.0	87.0	10.0	48.2	0.52	Magnetite
87.0	97.0	10.0	-	-	Greenstone

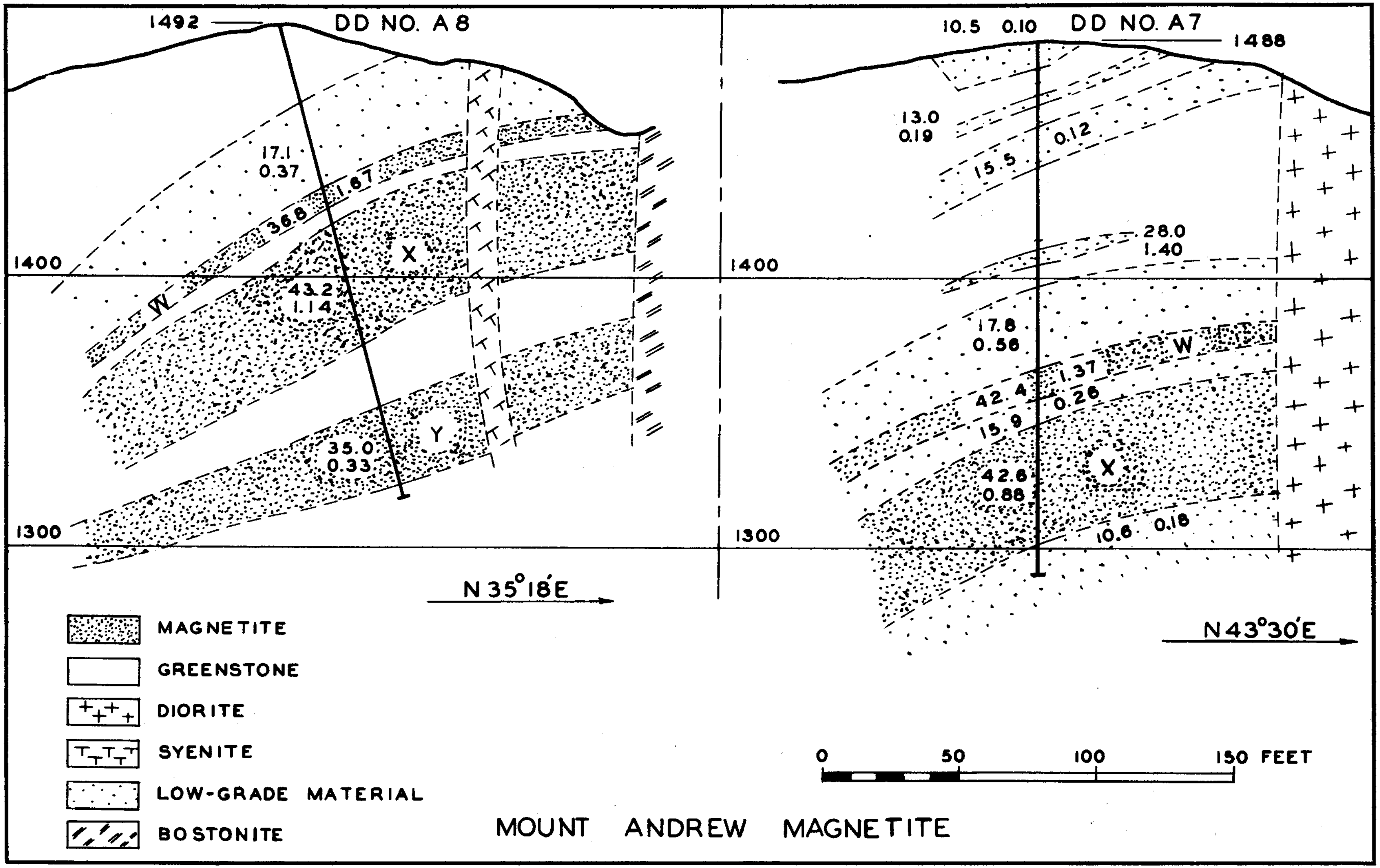


Figure 9. - Section of ore body XV, drill holes A7 and A8.

Hole 7 (fig. 6) (Continued)

Footage			Percent		
From	To	Feet	Fe	Cu	Formation
97.0	98.7	1.7	40.0	0.3(est.)	Magnetite
98.7	108.7	10.0	-	-	Greenstone
108.7	120.0	11.3	46.9	.55	Magnetite
120.0	138.2	18.2	-	-	Gabbro
138.2	143.0	4.8	54.0	.90	Magnetite
143.0	146.0	3.0	-	-	Greenstone
146.0	242.7	96.7	48.7	.66	Magnetite

Hole 14 (fig. 4)

Project 927; Mount Andrew, Alaska; dip, -50°; length, 180.8'; coordinates, 10389.5 N., 5545.0 E.; elev., 1,415'; bearing, east; date drilled, March 29 - April 18, 1944

Footage			Percent		
From	To	Feet	Fe	Cu	Formation
0.0	4.0	4.0	-	-	Overburden
4.0	7.0	3.0	49.9	0.66	Magnetite
7.0	26.0	19.0	-	-	Greenstone
26.0	29.0	3.0	24.6	.20	Mag. & gr.
29.0	38.5	9.5	58.2	.42	Magnetite
38.5	59.7	21.2	-	-	Diorite porph.
59.7	71.1	11.4	14.4	.56	Gr. & mag.
71.1	80.0	8.9	-	-	Greenstone
80.0	85.3	5.3	-	-	Gabbro
85.3	90.8	5.5	24.4	.15	Gr. & mag.
90.8	94.0	3.2	-	-	Greenstone
94.0	111.0	17.0	-	-	Syenite
111.0	116.5	5.5	40.2	.02	Magnetite
116.5	123.3	6.8	-	-	Greenstone
123.3	137.8	14.5	-	-	Diorite
137.8	144.0	6.2	-	-	Greenstone
144.0	151.0	7.0	36.9	.09	Gr. & mag.
151.0	166.2	15.2	-	-	Greenstone
166.2	175.0	8.8	16.6	.43	Gr. & mag.
175.0	177.2	2.2	-	-	Greenstone
177.2	180.8	3.6	-	-	Bostonite

Hole 20 (fig. 10)

Project 927; Mount Andrew, Alaska; dip, -90°; length, 250.9'; coordinates, 10358.0 N., 5442.0 E.; bearing,--; elev., 1,422'; dates drilled, July 19 - 28, 1944

Footage			Percent		
From	To	Feet	Fe	Cu	Formation
0.0	18.0	18.0	53.0	0.85	Magnetite
18.0	159.5	141.5	-	-	Diorite
159.5	166.0	6.5	49.4	1.21	Magnetite
166.0	188.4	22.4	-	-	Greenstone
188.4	190.8	2.4	35.9	.92	Magnetite
190.8	202.2	11.4	-	-	Greenstone
202.2	204.0	1.8	36.4	1.42	Mag. & gr.
204.0	215.0	11.0	-	-	Greenstone
215.0	216.5	1.5	30.(est.)	1.(est.)	Gr. & mag.
216.5	250.9	34.4	-	-	Greenstone

Hole 23 (fig. 10)

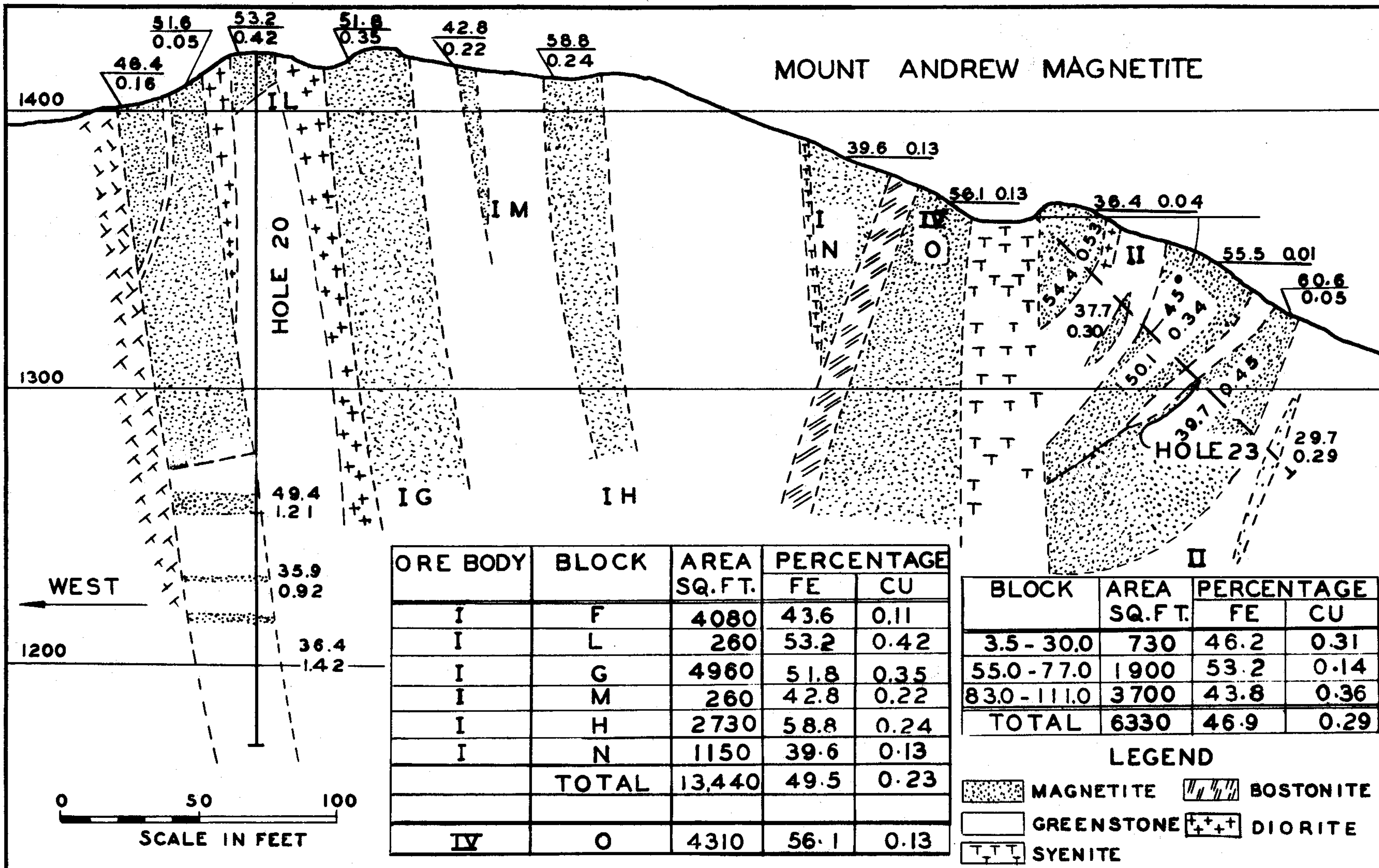
Project 927; Mount Andrew, Alaska; dip, -45°; length, 130.2'; coordinates, 10333.0 N., 5719.0 E., elev., 1,372'; bearing, N. 89° - 30' E.; dates drilled, June 30, July 4, 1944

Footage			Percent		
From	To	Feet	Fe	Cu	Formation
0.0	3.5	3.5	-	-	Overburden
3.5	30.0	26.5	54.4	0.53	Magnetite
30.0	32.0	2.0	-	-	Gabbro
32.0	45.0	13.0	-	-	Greenstone
45.0	50.0	5.0	37.7	.30	Mag. & gr.
50.0	55.0	5.0	-	.18	Greenstone
55.0	77.0	22.0	50.1	.34	Magnetite
77.0	83.0	6.0	-	-	Greenstone
83.0	111.0	28.0	39.7	.45	Mag. & gr.
111.0	119.0	8.0	-	-	Diorite porph.
119.0	125.0	6.0	29.7	.29	Mag. & gr.
125.0	130.2	5.2	-	-	Gr. & mag.

Hole 27 (fig. 11)

Project 927; Mount Andrew, Alaska; dip, -45-1/2°; length, 222.0'; coordinates, 10211.5 N., 5462.5 E.; elev., 1,398'; bearing, west; dates drilled, May 2 - 13, 1944

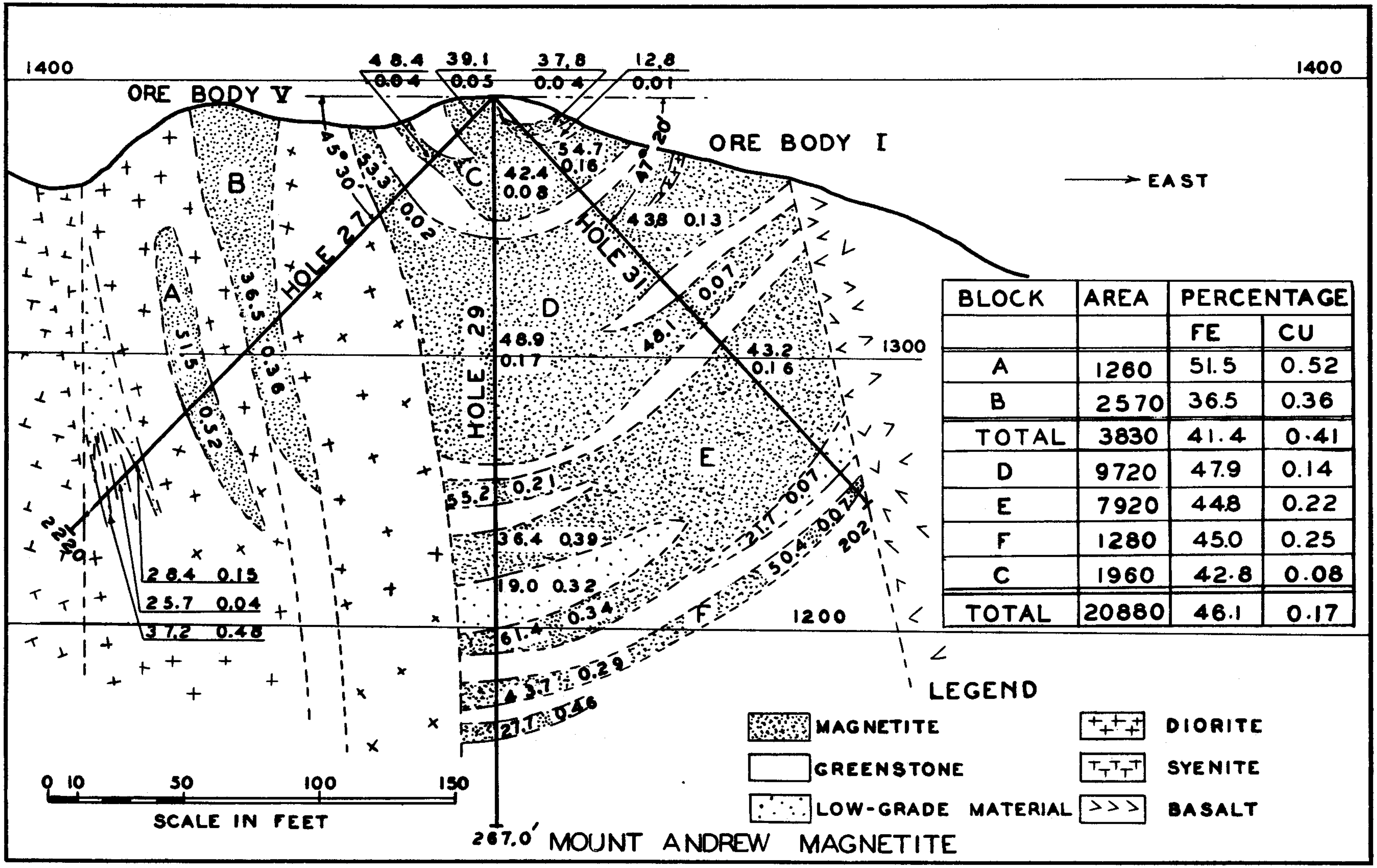
Footage			Percent		
From	To	Feet	Fe	Cu	Formation
0.0	19.0	19.0	39.1	0.05	Magnetite
19.0	31.0	12.0	-	-	Greenstone
31.0	36.0	5.0	48.4	.04	Magnetite
36.0	48.5	12.5	-	-	Greenstone



ORE BODY	BLOCK	AREA SQ.FT.	PERCENTAGE FE	PERCENTAGE CU
I	F	4080	43.6	0.11
I	L	260	53.2	0.42
I	G	4960	51.8	0.35
I	M	260	42.8	0.22
I	H	2730	58.8	0.24
I	N	1150	39.6	0.13
	TOTAL	13,440	49.5	0.23
IV	O	4310	56.1	0.13

BLOCK	AREA SQ.FT.	PERCENTAGE FE	PERCENTAGE CU
3.5 - 30.0	730	46.2	0.31
55.0 - 77.0	1900	53.2	0.14
83.0 - 111.0	3700	43.8	0.36
TOTAL	6330	46.9	0.29

Figure 10. - Section of ore bodies I, II, and IV, drill holes 20 and 23, trench IE.



BLOCK	AREA	PERCENTAGE	
		FE	CU
A	1260	51.5	0.52
B	2570	36.5	0.36
TOTAL	3830	41.4	0.41
D	9720	47.9	0.14
E	7920	44.8	0.22
F	1280	45.0	0.25
C	1960	42.8	0.08
TOTAL	20880	46.1	0.17

Figure 11. - Section of ore bodies I and V, drill holes 27, 29, and 31.

Hole 27 (fig. 11) (Continued)

Footage			Percent		
From	To	Feet	Fe	Cu	Formation
48.5	60.2	11.7	53.3	0.02	Magnetite
60.2	105.0	44.8	-	-	Greenstone
105.0	112.0	7.0	-	-	Do.
112.0	119.0	7.0	43.4	.13	Magnetite
119.0	121.0	2.0	-	-	Greenstone
121.0	128.2	7.2	39.9	.68	Magnetite
128.2	146.9	18.7	-	-	Syenite
146.9	160.0	13.1	51.5	.52	Magnetite
160.0	183.6	23.6	-	-	Syenite
183.6	187.7	4.1	28.4	.15	Mag. & gr.
187.7	191.4	3.7	-	-	Greenstone
191.4	198.5	7.1	25.7	.04	Mag. & gr.
198.5	200.3	1.8	-	-	Greenstone
200.3	200.7	.4	37.2	.48	Mag. & gr.
200.7	205.1	4.4	-	-	Greenstone
205.1	206.0	.9	40.0	Tr.(est.)	Magnetite
206.0	210.0	4.0	-	-	Greenstone
210.0	219.0	9.0	-	-	Diorite & gr.
219.0	222.0	3.0	-	-	Gray clay gouge

Hole 29 (fig. 11)

Project 927; Mount Andrew, Alaska; dip, -90°; length, 267.0'; coordinates, 10211.5 N., 5462.5 E.; bearing,--; elev., 1,398.0'; dates drilled, May 25, June 5, 1944

Footage			Percent		
From	To	Feet	Fe	Cu	Formation
0.0	45.0	45.0	42.4	0.08	Magnetite
45.0	55.0	10.0	22.2	.14	Mag. & gr.
55.0	135.5	80.5	48.9	.17	Magnetite
135.5	141.5	6.0	-	-	Greenstone
141.5	150.0	8.5	55.2	.21	Magnetite
150.0	160.0	10.0	-	-	Greenstone
160.0	175.0	15.0	36.4	.39	Mag. & gr.
175.0	197.0	22.0	19.0	.32	Do.
197.0	204.5	7.5	61.4	.34	Magnetite
204.5	215.0	10.5	-	-	Greenstone
215.0	225.8	10.8	43.7	.29	Magnetite
225.8	230.0	4.2	-	-	Greenstone
230.0	235.0	5.0	27.7	.46	Gr. & mag.
235.0	267.0	32.0	-	-	Greenstone

Hole 31 (fig. 11)

Project 927; Mount Andrew, Alaska; dip, -47° 20'; length, 202.0'; coordinates, 10211.5 N., 5462.5 E.; bearing, east; elev., 1,398.0'; dates drilled, May 15 - 24, 1944

Footage			Percent		
From	To	Feet	Fe	Cu	Formation
0.0	15.0	15.0	-	-	Greenstone
15.0	20.0	5.0	37.8	0.04	Magnetite
20.0	25.3	5.3	12.8	.01	Gr. & mag.
25.3	46.0	20.7	54.7	.16	Magnetite
46.0	54.0	8.0	-	-	Greenstone
54.0	90.0	36.0	43.8	.13	Magnetite
90.0	100.0	10.0	-	-	Greenstone
100.0	113.0	13.0	48.1	.07	Magnetite
113.0	123.0	10.0	-	-	Greenstone
123.0	175.0	52.0	43.2	.16	Magnetite
175.0	186.0	11.0	21.7	.07	Mag. & gr.
186.0	191.5	5.5	-	-	Greenstone
191.5	194.0	2.5	50.4	.07	Magnetite
194.0	202.0	8.0	-	-	Syenite

Hole 32 (fig. 12)

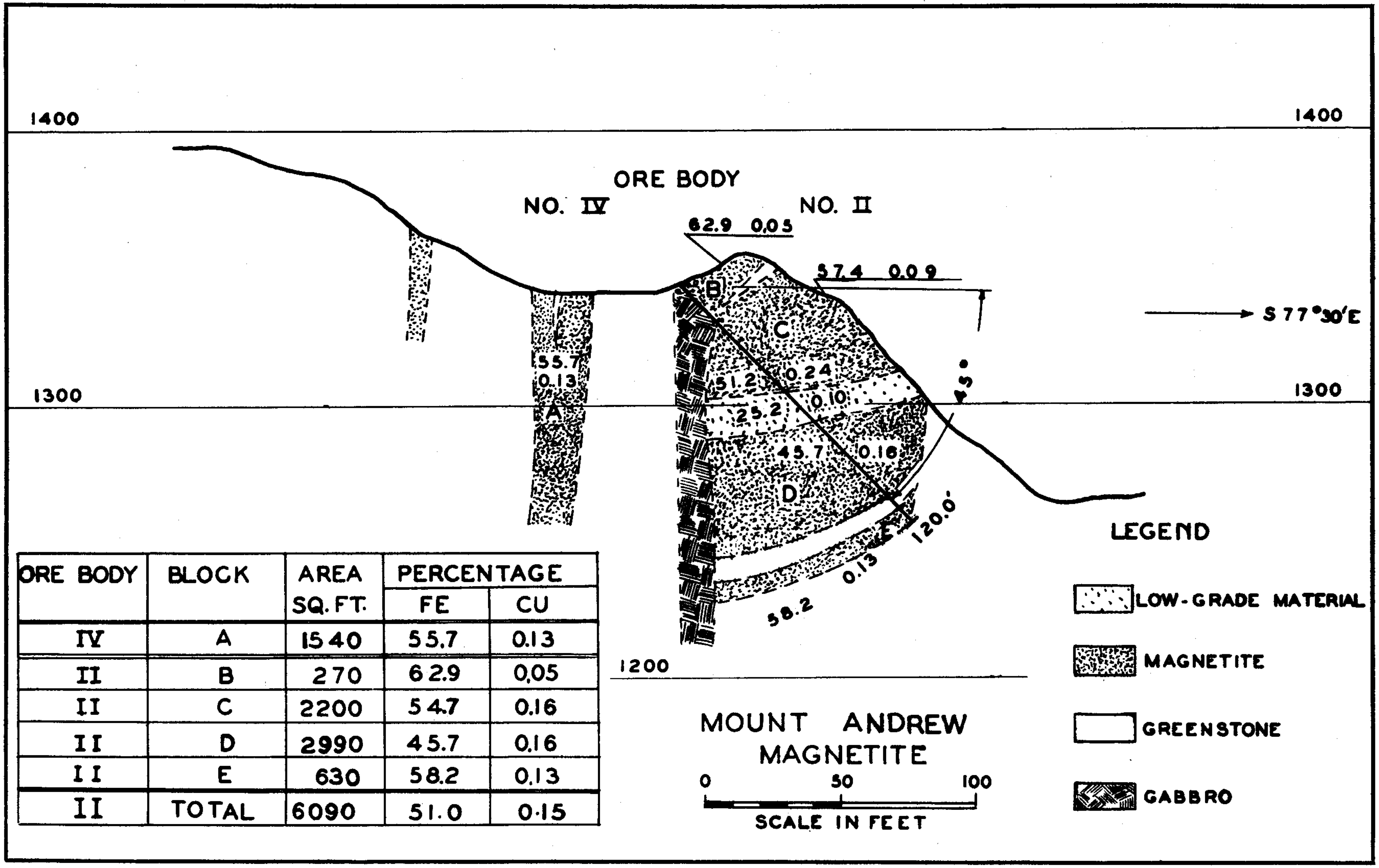
Project 927; Mount Andrew, Alaska; dip, -45°; length, 120.0'; coordinates, 10219.5 N., 5703.0 E.; elev., 1,343'; bearing, S. 77° 30' E.; dates drilled, June 26 - 30, 1944

Footage			Percent		
From	To	Feet	Fe	Cu	Formation
0.0	4.0	4.0	-	-	Overburden
4.0	18.0	14.0	-	-	Gabbro
18.0	55.0	37.0	51.2	0.24	Magnetite
55.0	70.0	15.0	25.2	.10	Mag. & gr.
70.0	107.5	37.5	45.7	.16	Mag. & little gr.
107.5	111.5	4.0	-	-	Greenstone
111.5	118.0	6.5	58.2	.13	Magnetite
118.0	120.0	2.0	-	-	Greenstone

Hole 37 (fig. 13)

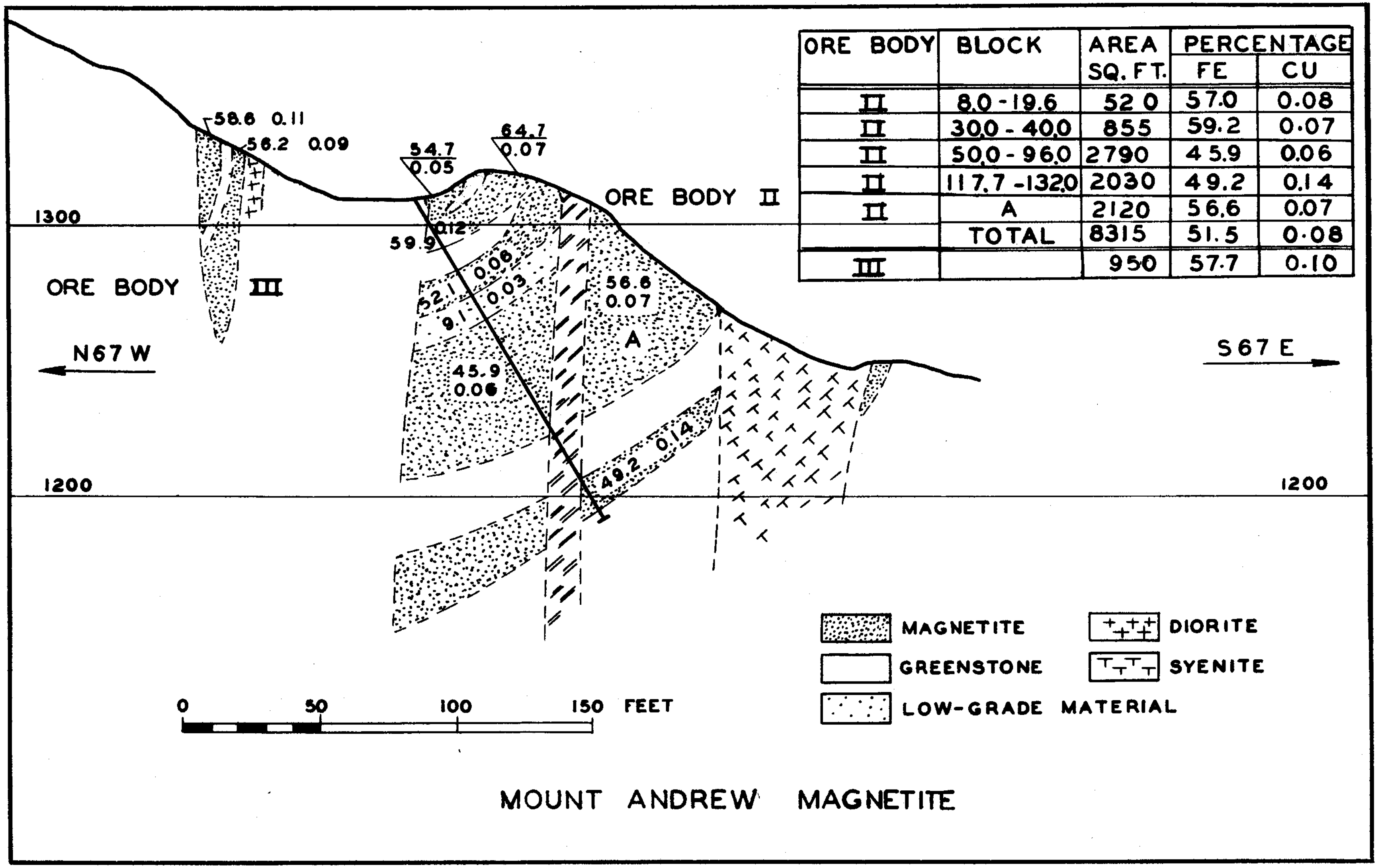
Project 927; Mount Andrew, Alaska; dip, -59° 30'; length, 136.5'; coordinates, 10100.5 N., 5652.0 E.; elev., 1,309'; bearing, S. 67° E.; dates drilled, June 17 - 24, 1944

Footage			Percent		
From	To	Feet	Fe	Cu	Formation
0.0	8.0	8.0	-	-	Greenstone
8.0	19.6	11.6	59.9	0.12	Magnetite
19.6	30.0	10.4	-	-	Greenstone
30.0	40.0	10.0	52.1	.06	Magnetite
40.0	50.0	10.0	9.1	.03	Greenstone



ORE BODY	BLOCK	AREA SQ. FT.	PERCENTAGE	
			FE	CU
IV	A	1540	55.7	0.13
II	B	270	62.9	0.05
II	C	2200	54.7	0.16
II	D	2990	45.7	0.16
II	E	630	58.2	0.13
II	TOTAL	6090	51.0	0.15

Figure 12. - Section of ore bodies IV and II, drill hole 32, trench 9.



ORE BODY	BLOCK	AREA SQ. FT.	PERCENTAGE FE	PERCENTAGE CU
II	8.0 - 19.6	520	57.0	0.08
II	30.0 - 40.0	855	59.2	0.07
II	50.0 - 96.0	2790	45.9	0.06
II	117.7 - 132.0	2030	49.2	0.14
II	A	2120	56.6	0.07
	TOTAL	8315	51.5	0.08
III		950	57.7	0.10

Figure 13. - Section of ore bodies II and III, drill hole 37, trench 3.

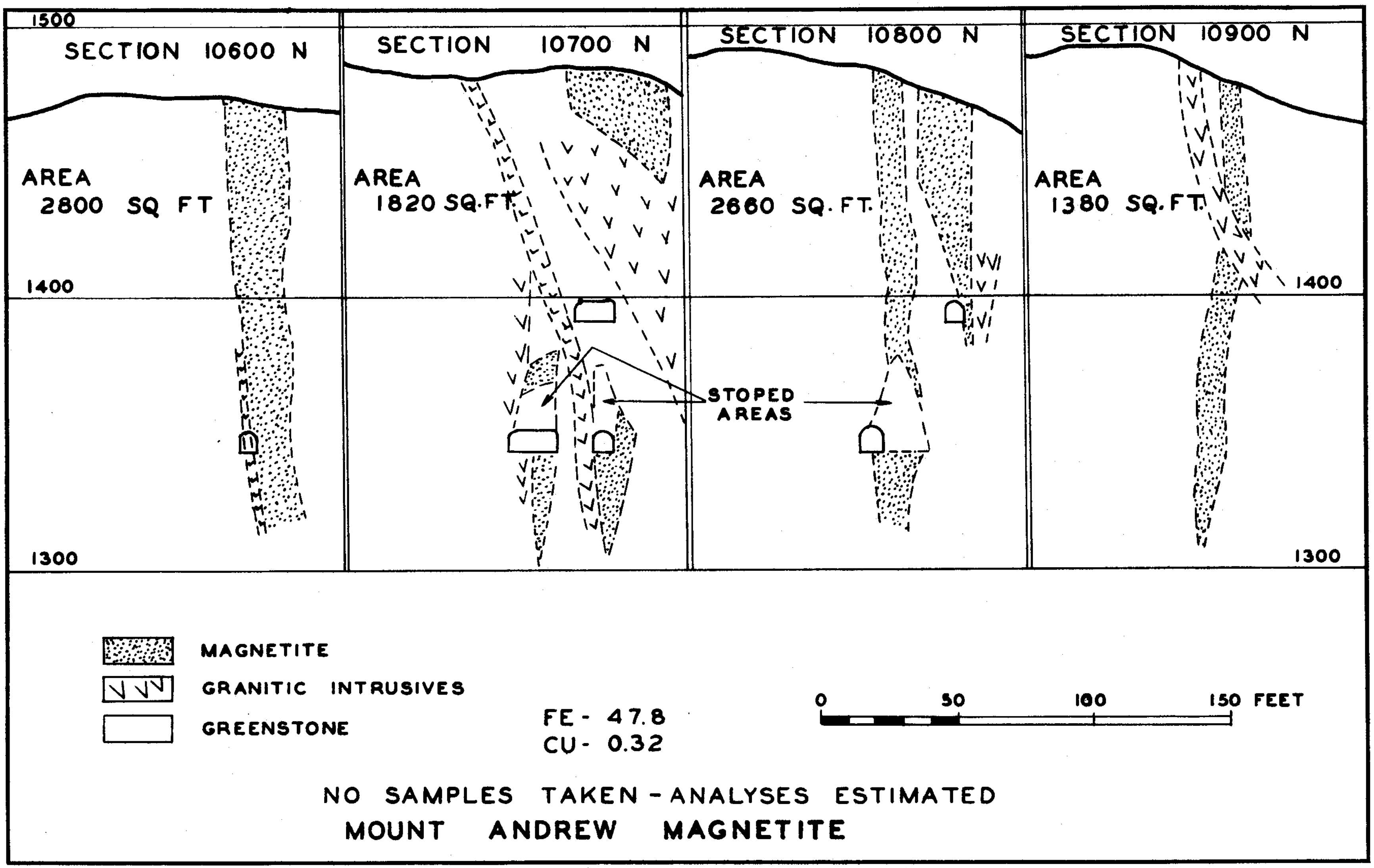


Figure 14. - Sections of ore body XIV at 5200 E.

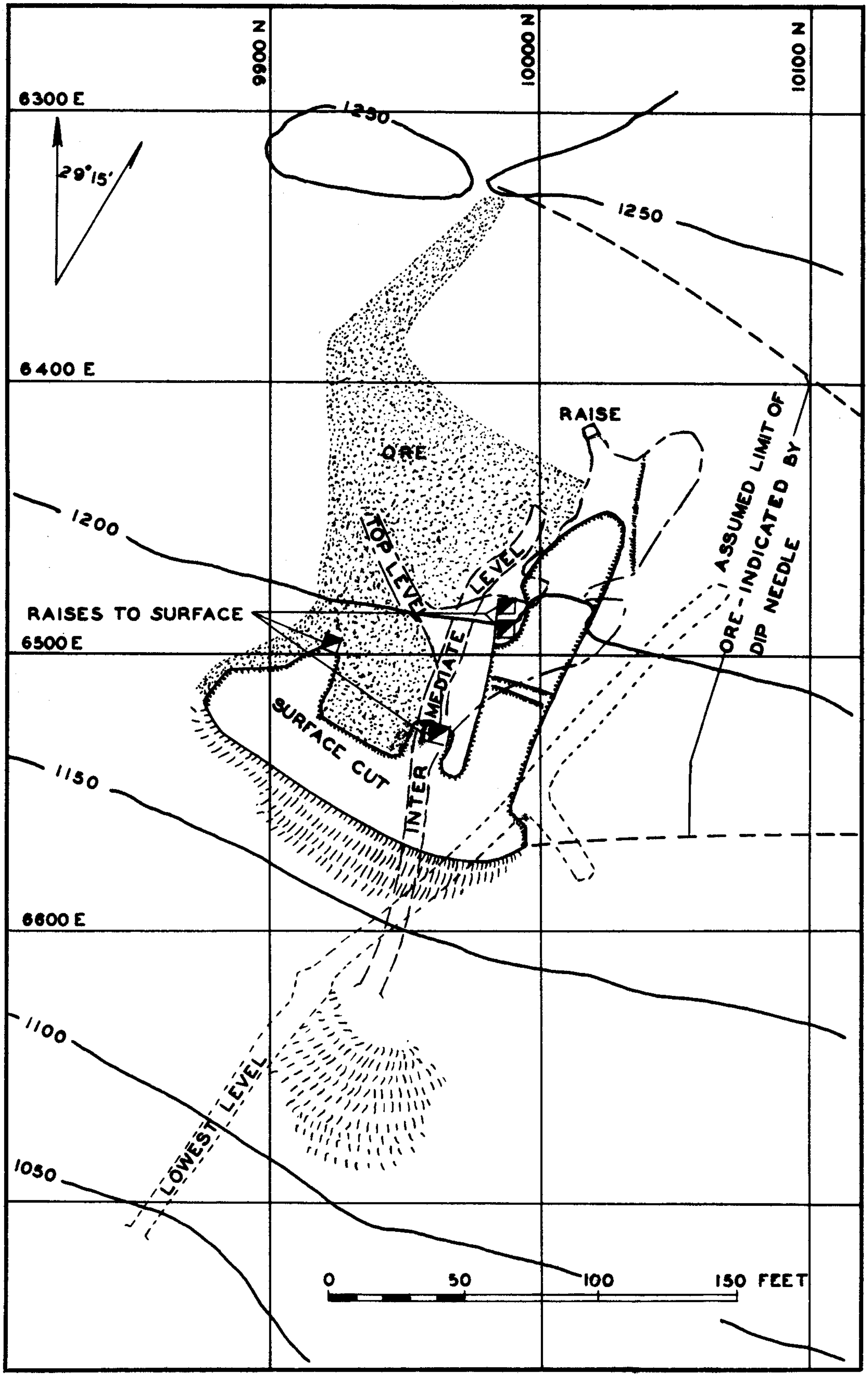


Figure 15. - Mayflower mine.

Hole 37 (fig. 13) (Continued)

Footage			Percent		
From	To	Feet	Fe	Cu	Formation
50.0	96.0	46.0	45.9	0.06	Magnetite
96.0	117.7	21.7	-	-	Greenstone
117.7	132.0	14.3	49.2	.14	Magnetite
132.0	136.5	4.5	-	-	Greenstone

Figure 14 shows sections drawn from observed mineral occurrences in the workings at the west end of the Mount Andrew mine. Figure 15 is a plan of the Mayflower mine and adjacent magnetite outcrops.

The average analyses for sulfur, phosphorus, lime, insoluble, gold and silver were derived from composite samples. Analyses of composite samples are shown in table 4 as follows:

TABLE 4. - Analyses of composite samples

Hole	Footage	Percentage						Oz. per short ton		Remarks
		Fe	Cu	Insol.	CaO	S	P	Au	Ag	
A1	14.5- 51.0			21.88	4.82	0.56	Tr.	Nil.	0.50	Sludge
A1	51.0- 79.0			25.64	1.94	.41	Tr.	Tr.	.10	Do.
A1	79.0-108.0			13.58	1.08	.96	Tr.	Tr.	.30	Do.
A3	30.0- 60.0	45.7	0.64	23.7	3.64	1.10	Tr.	0.01	.30	Do.
A3	31.1- 60.0	39.2	.26	32.4	4.0	1.18	Tr.	Nil.	.40	Core
A3	69.0- 85.0	40.9	.33	30.9	4.5	.46	Tr.	Tr.	.20	Do.
A3	115.8-128.5	52.6	.51	14.8	1.3	1.83	Tr.	0.01	.60	Do.
A3	133.7-169.7	44.0	.57	28.4	1.9	.82	Tr.	.01	.40	Do.
A4	20.0- 35.0	54.3	.17	13.6	3.2	.17	Tr.	.01	.60	Do.
A5	55.0-116.7	43.7	.13	24.0	5.6	.26	Tr.	.01	.20	Do.
A7	110.0-170.0	36.8	.38	34.5	5.5	.92	Tr.	.02	.30	Do.
A8	80.0-120.0	43.8	1.50	21.9	3.2	3.13	Tr.	.04	.50	Do.
A8	149.0-170.0	31.3	.26	28.4	11.4	.37	0.01	Tr.	.90	Do.
7	146.0-242.6	46.4	.55	27.0	1.15	1.02	Tr.	0.01	.70	Do.
7	146.0-210.0	55.0	.51	14.9	1.75	1.00	Tr.	-	-	Sludge
27	15.0- 60.0			33.81	5.55	Tr.	Tr.	Tr.	.40	Core
29	100.0-135.0	56.0	.24	16.8	1.00	.45	Tr.	-	-	Do.
31	54.0- 90.0	44.7	.17	27.7	2.45	.10	Tr.	-	-	Do.
31	145.0-186.0	36.0	.13	39.8	6.90	.10	Tr.	-	-	Do.
37	46.5-132.0	45.1	.10	27.3	2.6	.10	Tr.	Tr.	.50	Do.
Average				25.8	3.5	.71	Tr.	1/0.11	1/0.55	

1/ Per long ton.

Adjusted and weighted average of all samples show the following analysis:

	Percent
Iron	47.8
Copper	.32
Insoluble	25.8
Alumina	4.0 Est.
CaO	3.5
Phosphorus .....Tr. to	.01
Sulfur	.71
Gold	.011 oz. per long ton
Silver	.55 oz. per long ton

Other metals reported in the magnetite deposits of Kasaan Peninsula are: Cobalt, up to 0.05 percent; and magnesium, sodium, titanium, manganese, zinc, nickel, strontium, chromium, and vanadiaum in minor amounts.

DEVELOPMENT

The principal mine workings consist of a group of four glory holes, three adits, several winzes and a sublevel. Development workings aggregate about 4,000 feet and are confined principally to the north end of the ore zone as shown in figure 3. The portal of the main adit is at an elevation of 1,338 feet, and the sublevel is 50 feet lower. The upper adit is at an elevation of 1,392 feet. The lowest adit, which is 1,525 feet in length, undercuts the deposit at an elevation of 1,040 feet. Mine workings do not expose the compound ore body south of the Mount Andrew mine except in one glory hole at the northern edge and in a 12-foot adit in the cliff on its eastern border as shown in figure 3.

The ore is hard and firm; the country rock, mostly greenstone and diorite, is also firm, although it is cut by a few cracks, seams, and scattered small faults. Apparently no difficulties were encountered in early mining, as the ground still stands well in open stopes up to 40 feet in width. Some timbering was done, although it was confined mostly to drifts below shrinkage stopes.

There is no mining equipment aside from buildings already mentioned. The old tramway has been dismantled.

BENEFICIATION TESTS

Three samples of the copper-bearing iron ore were submitted to the Rolla laboratory for chemical analyses and metallurgical testing. The samples, designated as Mount Andrew Nos. 4, 5, and 6, were stated to represent the ore reserves. The sample, Mount Andrew No. 4, was blasted from the main tunnel of the "copper-rich" area. The Mount Andrew No. 5 was cut from the south rim of the glory hole near the boundary between the "copper-rich" and "magnetite-rich" areas. The Mount Andrew No. 6 was moiled and blasted from the "cliff deposit" of the "magnetite-rich" area. A report of the beneficiation test follows:

Part 1. - Mount Andrew Samples 4 and 5

Physical Character

The ores were described as near-contact replacement of limestone by the ore minerals chalcopyrite, magnetite, and pyrite and the gangue minerals epidote, garnet, pyrozene, calcite, and quartz. The ore, it is stated, is bordered by epidotized contact rocks and cut by diorite dikes.

Microscopic study of sized portions of the samples indicated a large part of the gangue minerals were free at 65-mesh but that minus 200-mesh grinding would be necessary to give complete liberation of the magnetite and sulfides.

Chemical Character

The analyses for the major constituents requested by the engineer who submitted the samples are:

Sample Description	Analysis, percent						
	Cu	Fe	SiO_2	Al_2O_3	S	P	CaO
Mount Andrew No. 4	0.68	48.9	11.5	3.9	1.79	0.03	0.65
Mount Andrew No. 5	.70	52.0	9.9	3.5	1.23	.02	.95

Less than 0.05 percent of each of the following constituents also were present: Manganese, nickel, cobalt, zinc, tungsten, vanadium and titanium.

Treatment Procedure

The two samples were so similar, chemically and mineralogically, that they were combined for the following treatment:

1. Flotation of copper minerals from the ore.
2. Magnetic separation of flotation tailing.
3. Sintering magnetic portion of flotation tailing.
4. Magnetic separation of the ore.

Treatment 4 failed to give a satisfactory separation of magnetite and sulfides except at minus 200-mesh. Hence, no further tests were made along these lines.

Flotation of Ore

Treatment

The sample was crushed to minus 20-mesh in a jaw crusher and rolls and ground to minus 65-mesh in a pebble mill. The ground pulp was conditioned with the reagents and floated in a mechanical-type cell at 25 percent solids. The rougher concentrate was cleaned four times to make the final copper concentrate.

Metallurgical data

Product	Weight, percent	Analysis, percent Cu	Analysis, percent Fe	Percent of total Cu	Percent of total Fe
Concentrate	2.9	21.0	35.2	90.4	2.0
Middling 1, 2, 3, 4	3.8	1.2	37.9	6.8	2.8
Tailing	93.3	.02	51.9	2.8	95.2
Head (calculated)	100.0	.67	50.9	100.0	100.0

Operating data

Reagent	Pounds per ton of feed: Conditioners 1	Conditioners 2	Rougher	Cleaners 1	Cleaners 2	Cleaners 3	Cleaners 4
Soda ash	2.0						
Sodium cyanide..				0.30	0.20		
Potassium1/		0.30					
Amyl xanthate ..							
Pine oil2/		.12					
pH			9.0				
Time (minutes)..	5	5	10	5	4	4	4

1/ American Cyanamid Co.
2/ Hercules Powder Co., Yarmor "F" brand.

A recovery of 90.4 percent of the copper was obtained in a concentrate containing 21.0 percent copper and 35.2 percent iron. A higher-grade concentrate may be produced at a reduced recovery. For instance, in other tests, a concentrate containing 23.1 percent copper was made with 82.5 percent recovery, and one containing 26.4 percent copper was made with a recovery of 59.0 percent.

Magnetic Separation of Flotation Tailing

Treatment

A sample of the flotation tailing was separated in the Davis tube, a low-intensity, wet-magnetic separator, into magnetic and nonmagnetic products.

Metallurgical data

Product	Weight, percent	Analysis, percent Fe	Insol.	SiO_2	P	S	Percent of total Fe	Insol.
Magnetic	80.1	63.2	7.4	4.5	0.01	0.08	98.2	31.0
Nonmagnetic	19.9	4.7	66.3				1.8	69.0
Feed (calculated)	100.0	51.6	19.1				100.0	100.0

The magnetic product contained 98.2 percent of the iron in the feed or 93.4 percent of the iron in the crude ore.

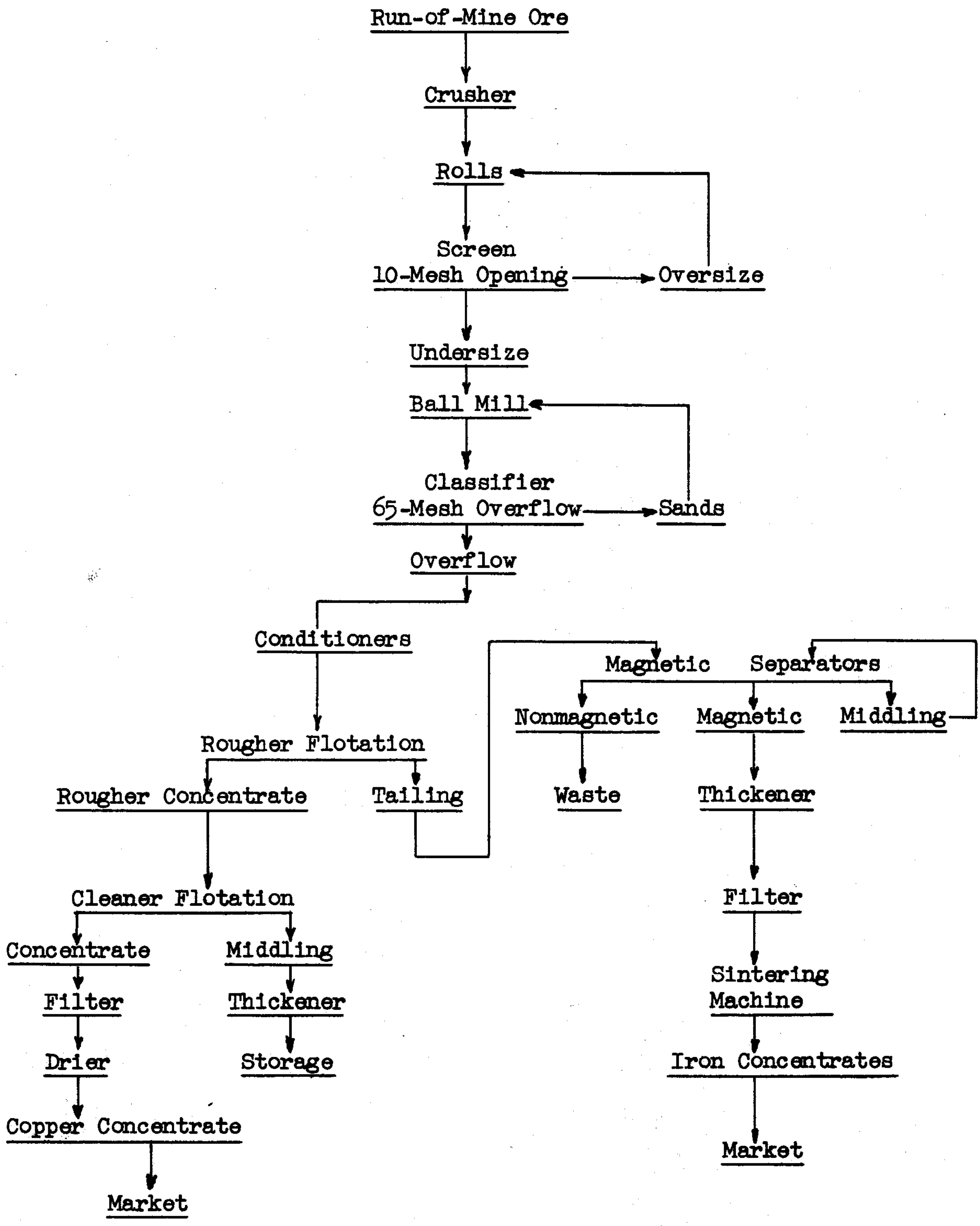


Figure 16. - Suggested flow sheet for milling ore from the "copper-rich" area of the Mount Andrew mine.

Sintering Magnetic Portion of Flotation Tailing

Treatment

In order to meet size requirements for iron ore, the magnetic product must be sintered or briquetted. If sintering is used, the coke employed in the process will add to the silica content of the final product. However, this will be counteracted to some extent by an increase in iron content due to loss of volatile constituents in the sample. In addition, the process will reduce the sulfur content of the sinter.

A sample of the magnetic product was mixed with coke and water in the following proportions: Ore - 80 percent, coke - 13 percent, water - 7 percent, and sintered in a down-draft laboratory sintering machine.

Metallurgical data

Magnetic product	Analysis, percent			
	Fe	SiO_2	P	S
Unsintered	63.2	4.5	0.01	0.08
Sintered	63.6	5.8	.01	.05

The iron content of the sintered product was very little changed but, as expected, the silica was increased and the sulfur reduced.

Summary and Conclusions

Laboratory investigation of a composite sample from the "copper-rich" area of the Mount Andrew mine gave excellent recoveries of copper and iron by flotation, magnetic separation and sintering. The grades and recoveries are shown below:

Summary of results

Product	Analysis, percent					Recovery, percent	
	Cu	Fe	SiO_2	P	S	Cu	Fe
Copper concentrate	21.0	35.2				90.4	2.0
Iron concentrate		63.6	5.8	0.01	0.05		93.4

A suggested flow sheet for milling the ore is appended (fig. 16). It is suggested that the flotation middling, which contains more than 1.0 percent copper and most of the pyrite, be thickened and impounded for future treatment. The circulation of this product in the circuit would result in the contamination of both products.

Part 2. - Mount Andrew Sample 6

Physical Character

The sample was described as primarily a massive magnetite with some chalcopyrite, pyrite, epidote, garnet, quartz, and calcite dispersed throughout and in segregation.

Chemical Character

Numerous chemical analyses were requested for Mount Andrew sample 6 also. The analyses of the major constituents are:

Analysis, percent						
Cu	Fe	SiO_2	Al_2O_3	S	P	CaO
0.05	58.3	6.7	3.4	0.16	0.02	0.8

Less than 0.05 percent of each of the following elements also was present: Manganese, nickel, cobalt, zinc, tungsten, vanadium, and titanium.

Treatment Procedure

Since the ore contained too little copper to be economically recovered, the problem was one of reducing the sulfur content to produce an acceptable iron product. The following procedures were investigated:

1. Magnetic separation of the ore, crushed to various sizes.
2. Sintering the ore.

Magnetic Separation of Ore

Treatment

Separate charges of the ore were ground to minus 20-, minus 48-, and minus 100-mesh. The ground samples were separated in the Davis magnetic tube previously mentioned.

Metallurgical data

Product	Weight percent	Analysis, percent					Percent of total		
		Fe	SiO_2	Cu	P	S	Fe	SiO_2	Cu
Minus 20-mesh									
Magnetic	91.9	63.1	5.0	0.04	0.007	0.12	99.0	62.0	80.4
Nonmagnetic	8.1	7.4	34.8	.11			1.0	38.0	19.6
Head (calc.)	100.0	58.6	7.4	.05			100.0	100.0	100.0
Minus 48-mesh									
Magnetic	89.4	66.3	3.0	.02	.003	.05	98.8	41.6	50.0
Nonmagnetic	10.6	6.7	35.6	.17			1.2	58.4	50.0
Head (calc.)	100.0	60.0	6.5	.04			100.0	100.0	100.0
Minus 100-mesh									
Magnetic	88.2	67.3	1.8	.01	.003	.02	98.8	27.9	14.8
Nonmagnetic	11.8	6.2	34.8	.44			1.2	72.1	85.2
Head (calc.)	100.0	60.1	5.7	.06			100.0	100.0	100.0

A satisfactory separation of iron and sulfur was obtained at minus 48-mesh. The recovery of iron from all the sizes was almost complete. Since the magnetic product is finely divided, it would have to be sintered to meet size requirements. This would give a further reduction in the sulfur content.

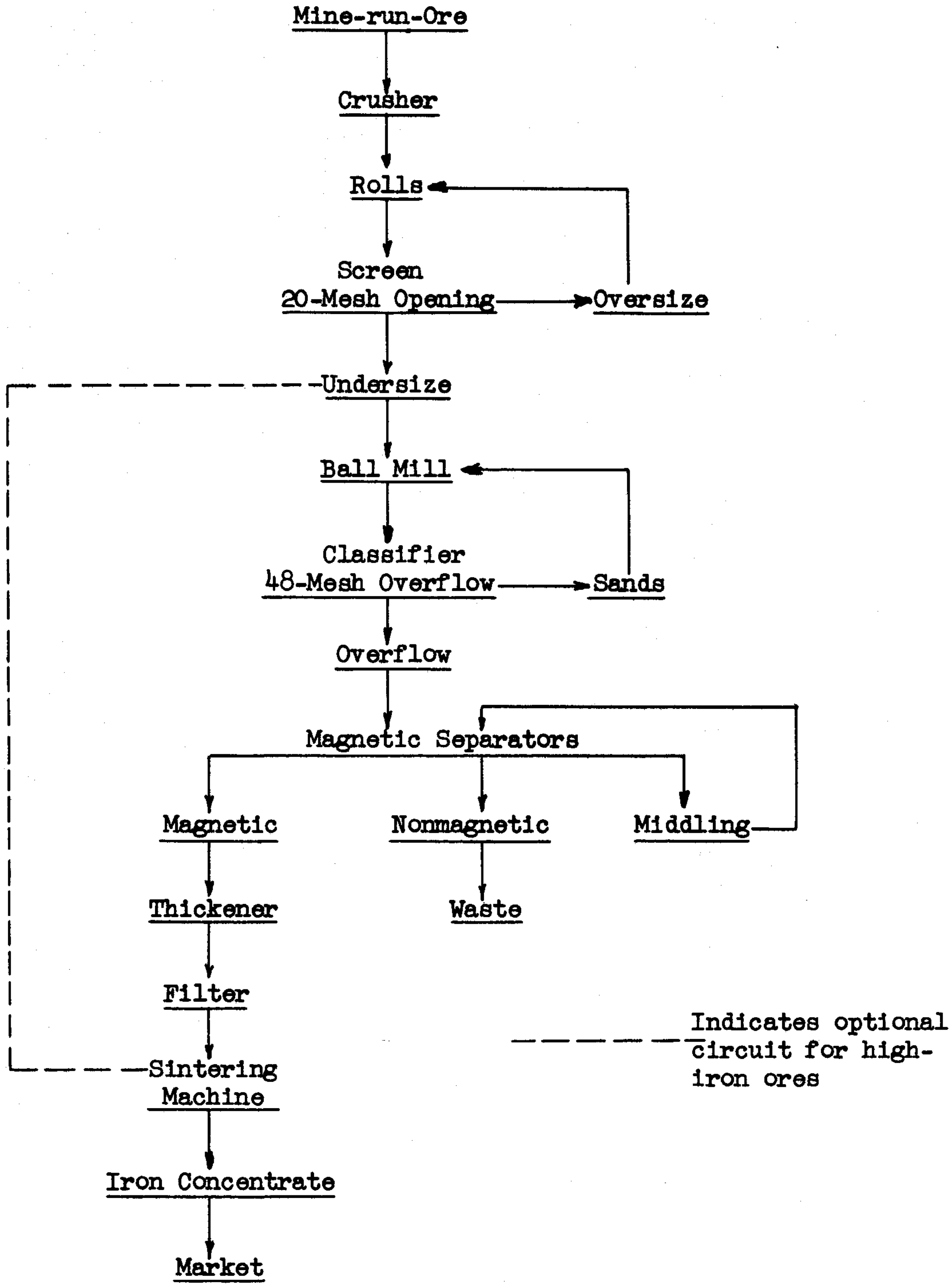


Figure 17. - Suggested flow sheet for milling ore from the "magnetite-rich" area of the Mount Andrew mine.

Sintering Ore

Treatment

A sample of the crude ore was crushed to minus 20-mesh, mixed with coke and water, and sintered. The following charge was used: Ore - 80 percent, coke - 12 percent and water - 8 percent.

Metallurgical data

Head sample	Analysis, percent			
	Fe	SiO_2	P	S
Unsintered	58.3	6.7	0.02	0.16
Sintered	59.0	9.2	.02	.06

The product obtained by sintering the head sample is not as high in iron as that obtained by magnetic separation, but it should be acceptable as an iron concentrate.

Summary and Conclusions

Laboratory study of this sample from the "magnetite-rich" area of the Mount Andrew mine, has shown that a high-grade iron concentrate is recoverable by magnetic separation or by sintering. Ore as high in iron as the one investigated needs only to be crushed and sintered to produce a merchantable iron ore. On the other hand, when material high in gangue is encountered, further grinding and magnetic separation must be used in addition to sintering. This is indicated on the following flow sheet (fig. 17).

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