R. I. 4275 MAY 1948

UNITED STATES
DEPARTMENT OF THE INTERIOR
J. A. KRUG, SECRETARY

BUREAU OF MINES
JAMES BOYD, DIRECTOR

REPORT OF INVESTIGATIONS

ARTILLERY PEAK MANGANESE DEPOSITS

MOHAVE COUNTY, ARIZ.

BY

ROBERT S. SANFORD AND LINCOLN A. STEWART

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1/ The Bureau of Mines will welcome reprinting of this paper, provided the following footnote acknowledgment is made: "Reprinted from Bureau of Mines Report of Investigations 4275."

2/ Mining engineer, Bureau of Mines.

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INTRODUCTION AND RÉSUMÉ

Intensive investigations of domestic manganese deposits were conducted by the Bureau of Mines and the Geological Survey during the earlier part of the war minerals investigations when there was doubt that the quantity of manganese needed to produce the greatly increased tonnage of steel demanded for war supplies could be obtained from its customary sources. Domestic deposits of ores that contain sufficient manganese for direct production of ferromanganese essential in steel manufacture are generally small, and the bulk of the supply is imported.

One of the few large deposits of low-grade manganese ore known in the United States is in the Artillery Peak district in southern Mohave County, Ariz. Manganiferous sediments underlie a very large area. Several large groups of claims, covering the most of the manganese-bearing ground, were assembled in 1929 and 1930. The greater part of this area was leased by the M. A. Hanna Co. in 1937. Investigations by engineers and geologists for this company revealed that the average content of manganese is very low; but that the Maggie Canyon area, about 180 acres, contains higher-grade material. The company put down 28 vertical diamond-drill holes to explore this ground, under the direction of B. N. Webber, geologist.

S. G. Lasky and R. G. Roberts, geologists of the Federal Geological Survey, made an intensive study of the deposit in 1939 and 1940 and reported that the manganese oxide was deposited along with gravel, sand, and clay in alluvial fans and playas within a basin between the Artillery and Rawhide Mountains. This material was swept down from the surrounding mountains by torrential rains from one side or another of the desert basin. The fans overlapped, and the playas migrated as the basin was filled. It is

believed that the manganese, except for richer "hard ore", remains in its original state and locale. The "hard ore" occurs in a zone near the top of the manganiferous sediments. It is believed that this was enriched by redeposition of manganese dissolved and transported by percolating waters before the sediments were capped by lava flows and possibly to some extent since that time by infiltration along the basalt contact.

In a deposit of this nature, the assumption that a given bed is continuous in thickness and grade for distances of 600 to 1,500 feet (the spacing of the holes drilled by the Hanna Co.) may lead to erroneous conclusions. Accordingly, the Bureau of Mines drilled 15 additional holes between those already drilled to get closer sampling and a more reliable estimate of the available tonnage of manganese ore.

Some experimental mining was done to determine the mining characteristics of the ore and the strength of the roof and to test the applicability of a room-and-pillar method of mining to this ore deposit. A lot of 2,500 tons of ore was shipped to the experimental plant at Boulder City, Nev., for metallurgical testing.

The project was started in November 1940 and completed in June 1941. The factual data obtained are given in the body of this report. Drill-hole logs and all sample data are appended.

The report also contains a brief discussion of metallurgical treatment of this ore. Concentration does not yield a metallurgical-grade product except at a prohibitive sacrifice of recovery. Two hydrometallurgical processes are available but have not been worked out to a conclusion on this ore. A combination of flotation and leaching may prove applicable to the ore.

ACKNOWLEDGMENTS

In its program of investigation of mineral deposits, the Bureau of Mines has as its primary objective the more effective utilization of our mineral resources to the end that they make the greatest possible contribution to national security and economy. The Mining Division, Lowell B. Moon, chief, conducts preliminary examinations, does the actual investigative work, and prepares the final report. The Metallurgical Division, O. C. Ralston, chief, analyzes samples and makes beneficiation tests.

In respect to the investigations reported in this paper, the activities of the Mining Division were directed by E. D. Gardner, supervising engineer, Southwest Experiment Station, Tucson, Ariz. J. H. Hedges, in Preliminary Report 1, Manganese at Artillery Peak, Ariz. (unpublished), outlined the plan for exploration and diamond drilling. Samples were analyzed at the Bureau's Reno laboratory, E. S. Leaver, supervising engineer. Robert S. Sanford was project engineer.

Special acknowledgment is made for the assistance and cooperation of S. G. Lasky, Vard Johnson, and Charles B. Hunt, of the Federal Geological

Survey. Lasky had completed a detailed geological study of the area, and his advice and suggestions were of special value. Johnson surveyed the drill-hole locations, logged part of the holes, and assisted in the calculation of ore reserve. Charles B. Hunt completed the drill-hole logs.

Acknowledgment is also made to Guy B. Hunner and Mack C. Lake, of the M. A. Hanna Co., for their valuable suggestions.

LOCATION AND ASSESSIBILITY

The Artillery Peak manganese deposits lie within an area of about 25 square miles in the dissected valley between the Artillery and Rawhide Mountains in the southeastern corner of Mohave County, Ariz., a few miles west of where the Big Sandy and Santa Maria Rivers join to form the Bill Williams River and about 30 miles due east of Parker Dam on the Colorado River (fig. 1). The explored area is in the foothills on the southwest flank of the Artillery Mountains. The locality is isolated but accessible by a desert road from Yucca, about 55 miles northwest from the Maggie adit, the center of Bureau operation, and 70 miles from the camp at Manganese Mesa. The Hanna Co. later cut a grade out of Maggie Canyon onto the mesa which reduced the road distance between the Maggie adit and the camp to a little more than a mile.

Yucca is on the main line of the Atchison, Topeka & Santa Fe Railway. Kingman, an excellent trading center, is 21 miles north of Yucca on U. S. Highways 66, 93, and 466 and is also on the Santa Fe Railway. During the flood season it is often impossible to ford the Bill Williams River at Alamo for months at a time. When the river can be forded the area is accessible by desert road from Congress Junction about 53 miles east. Congress Junction, on the Santa Fe Railway and U. S. Highway 89, is 15 miles north of Wickenburg.

CLIMATE AND VEGETATION

The exploration camp on Manganese Mesa was at an altitude of 2,500 feet. No Weather Bureau records are available for the vicinity. The climate is mild during the winter months, and frost is rare. The thermometer often registers 120° F. in summer. The annual rainfall is only about 6 inches, but torrential rains often leave roads impassable for days. There is no water on Manganese Mesa. All water for drilling and camp use had to be hauled 8 miles from a well near the Bill Williams River.

If large-scale mining and milling operations are undertaken, an adequate water supply can be secured from the Bill Williams River. A pipe line 4 to 8 miles long, depending on mill and townsite locations, would have to be provided.

The only vegetation is several varieties of cacti and a few palo verde trees.

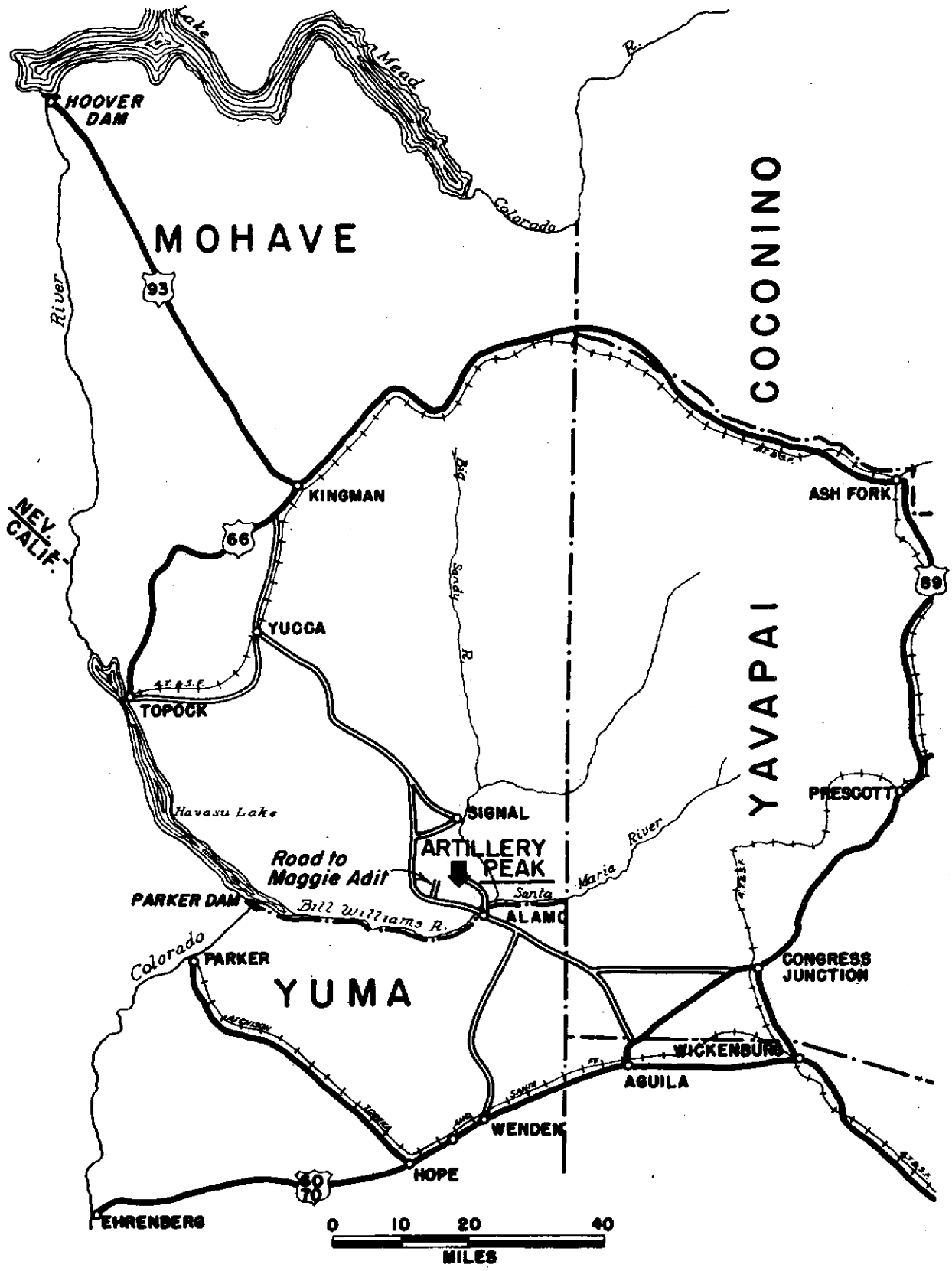

Figure 1. - Location map, Artillery Peak manganese, Mohave County, Ariz.

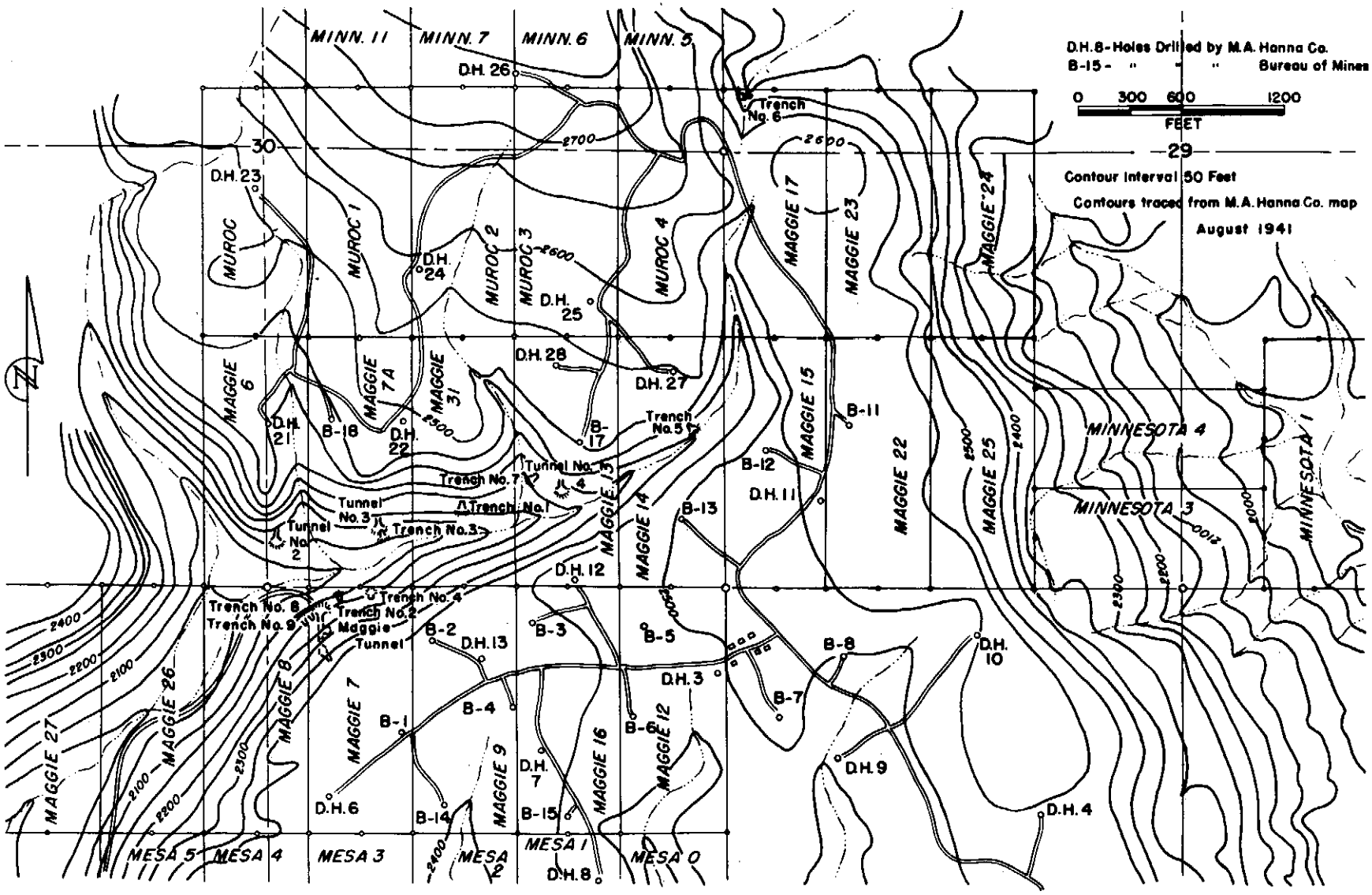

Figure 2. - Project area, Artillery Peak manganese, Mohave County, Ariz.

PROPERTY AND OWNERSHIP

Exploration by the Bureau of Mines was confined to an area covered by 13 patented mining claims: Maggie Nos. 6, 7, 7A, 9, 12 to 16, 24 to 26, and 31; 6 unpatented mining claims: Maggie Nos. 8, 17, 22, 23, and 27, and Mesa No. 1, in secs. 29, 30, and 31, and in the NW1/4 sec. 32. All are in T. 12 N., R. 13 W (fig. 2). The Manganese Ore Co., a subsidiary of the M. A. Hanna Co. of Cleveland, Ohio, controlled the property at that time.

HISTORY AND PRODUCTION

The old Alamo to Signal road was built about 1860. Prominent outcrops along this road were identified as manganese ore about 1880. The manganese deposits are low-grade and transportation was so costly that development was not undertaken for many years.

Will Rogers located five claims along the old Signal road in 1909. After his death his two sons, Elmer R. and E. D. Rogers, took over the claims and held them until 1925.3/ During the first World War, development was undertaken by W. J. Graham, T. R. McComas, J. Shanahan, S. K. Barber, J. Carr, and others. The end of the war and the drop in manganese prices came before any ore could be shipped. According to Lee Eaton, four carloads of sorted ore, containing 41 to 45 percent manganese, were shipped to Birmingham, Ala., in 1928.4/ One carload of sorted manganese ore was shipped from the Black Warrior mine in November 1940.

Mack C. Lake first examined the area in 1929 and, recognizing its importance, persuaded the Chapin Bros. of Chicago to finance the Chapin Exploration Co. and to acquire about 1,700 acres of promising ground. The Arizona Manganese Corp. acquired adjacent claims, together with the newly discovered outcrops in Maggie Canyon, in 1930.

In 1937 the M. A. Hanna Co. obtained by lease and sublease about 2,500 acres from Lake, who either owned or had leases on most of the known manganese in the district. This land was owned by Lake, the Chapin Exploration Co., and the Arizona Manganese Corp. The M. A. Hanna Co. started exploration of the property by diamond core drilling in June 1937, and continued intermittently to April 1940, completing 28 holes.

GEOLOGY

Origin and Physical Aspects of Manganese-Bearing Formation:

(From an upublished report, Manganese at Artillery Peak, Ariz., by J. H. Hedges.)

Detailed study and mapping of the geology of the area by S. G. Lasky and R. G. Roberts of the Geological Survey, in cooperation with B. N. Webber, geologist for the M. A. Hanna

3/ Oral communication by Elmer R. Rogers.
4/ Manganese Ore Deposits in Ariz.: Arizona Bureau of Mines, Bull. 127, p. 71.

Co., working under the direction of M. C. Lake, have led to the following conclusions, summarized from the report by Lasky and Webber.5/

The principal manganese-bearing horizon, called the Chapin Wash formation, is made up of a series of interbedded alluvial fan and playa deposits comprising sandstones, silts, clays, conglomerates, and a few thin beds of tuff and limestone. The maximum thickness is about 1,500 feet, thinning toward the margins of the basin in which it was deposited and pinching out at the edges between the older and younger formations.

The material of the Chapin Wash formation was derived from disintegration and erosion of the older rocks on which it rests, washed by flood and cloudburst into a closed basin probably formed by subsidence of a large graben block. The debris from the surrounding hills was deposited in alluvial fans or in playas that migrated from time to time as floods descended from one side or another of the desert basin. Evidence seems conclusive that the manganese was washed in along with the other ingredients, forming syngenetic deposits of manganese oxides at numerous horizons and in widely varying degrees of concentration. The source of so much manganese has not been found, but it is thought to have been derived largely from contemporaneous activity of hot springs surrounding the basin, and to a lesser extent from disintegration of the older rocks. In any event, with minor exceptions, there is no evidence of replacement or impregnation, and it must be concluded that the manganese was deposited at the same time as the sands, clays, and other wash materials with which it is now associated.

The period of deposition was brought to a close by a flow of basalt that rests conformably on the Chapin Wash formation, followed by a period of erosion during which much of the basalt and the Chapin Wash formation were removed, and the Sandtrap conglomerate was laid down on the eroded surface. A succession of basalt flows then covered the area. Subsequent faulting and erosion exposed the manganiferous sediments and produced the present topography of which basalt-capped mesas are a prominent feature.

The conditions under which the Chapin Wash formation appears to have been laid down suggest interfingering of excessive beds that would make correlation of widely separated exposures difficult and uncertain and restrict the distance to which a given bed might be projected with confidence. Likewise, well-mineralized strata at different

5/ Lasky, S. G. and Webber, B. N., Manganese Deposits in the Artillery Mountains Region, Mohave County, Ariz.: Geol. Survey Bull. 936-R, 1944, pp. 417-448.

exposures, seemingly at the same horizon, might prove to be quite unconnected. These considerations indicate the need for closer sampling, by drilling or other means, than is required for deposits formed by replacement or impregnation of strata more uniform in character.

MANGANESE DEPOSITS

In describing the ore, Hedges says:

> Stratified deposits of manganese occur both in older and younger formations, and manganese oxide is found filling fault and fissure veins, but the bedded deposits of the Chapin Wash formation alone contain enough manganese to be of possible commercial value, and commercial investigation has been confined to these deposits. All others may be dismissed from present consideration.
>
> The maganiferous beds are found at numerous horizons separated by barren material and include all the kinds of rock that compose the Chapin Wash formation. The manganese was deposited with the sediments; and, where exposed in outcrops, the manganiferous beds are observed to lens in and out with barren beds or to grade into barren material by fading out of the manganese oxides.
>
> The ore material falls into three distinct groups, classified by Lasky as follows:
>
> 1. Sandstone ore, friable to compact siltstone, sandstones, and conglomerates.
>
> 2. Clay ore, including clay and mudstone.
>
> 3. Hard cemented ore that is a supergene modification of the sandstone ore.
>
> Classes 1 and 2 comprise the unaltered syngenetic deposits, whereas class 3 has been cemented and locally enriched or impoverished by supergene action that gave rise to the higher-grade bodies of immediate commercial interest.

In the interpretation of the results of surface sampling and drilling by the Bureau it was found that three tuff beds could be identified over part of the area, and a main tuff bed was present over nearly the entire area. The tuff is characterized by shards, or needles of volcanic glass, so long and slender that it appears that the tuff is a volcanic ash that has not been transported. As the manganiferous beds are syngenetic, the manganese having been washed in with the other ingredients, a bed of tuff

composed of volcanic ash would constitute an excellent horizon marker. Correlating the manganese beds with reference to this marker, it was found that they did not occupy the same horizon; that interfingering did exist; and that the mineralized beds were not always continuous from one sample point to the next.

The hard ore is a product of alteration or secondary enrichment of the primary sandstone ore. The evidence seems conclusive that lateral migration along porous beds occurred. The core drilling proved that weakly mineralized areas do exist between enriched bodies of ore.

WORK BY BUREAU OF MINES

Camp

There were no buildings on or near the area to be explored; consequently, it was necessary for the Bureau to build a camp for its workmen and those of the diamond drill contractor.

Seven floored tents were erected on Manganese Mesa for living quarters of the 28 men employed on the project. An office building and a combined mess hall and kitchen were constructed of shiplap lumber.

Road and Trail Building

A total of 4,880 linear feet of road was cleared and leveled by hand to drill-hole locations and 11,100 linear feet of haul road from the county road to the Maggie adit was built. The construction of these roads, about 10 feet wide, necessitated the excavation of a total of 5,020 cubic yards of alluvium and loose and solid rock.

Trenching

Nine trenches, with average cross section of 2.0 by 4.2 feet were excavated for a total of 140 linear feet. Twenty-one cubic yards of alluvium, 18 of loose rock, and 4 of solid rock were removed in this work. (See figs. 3 and 4.)

Diamond Drilling

Drilling was done by the Sullivan Machinery Co., Michigan City, Ind., under contract IM-835, dated November 22, 1940, according to the following schedule:

Item	Article or Service	Quantity	Unit	Price
	Diamond drill-core boring	3,000 ft.		
1	Diamond drill-core boring "NX" bit		foot	$3.85
2	Diamond drill-core boring "BX" bit		foot	3.50
3	Diamond drill-core boring "AX" bit		foot	3.20

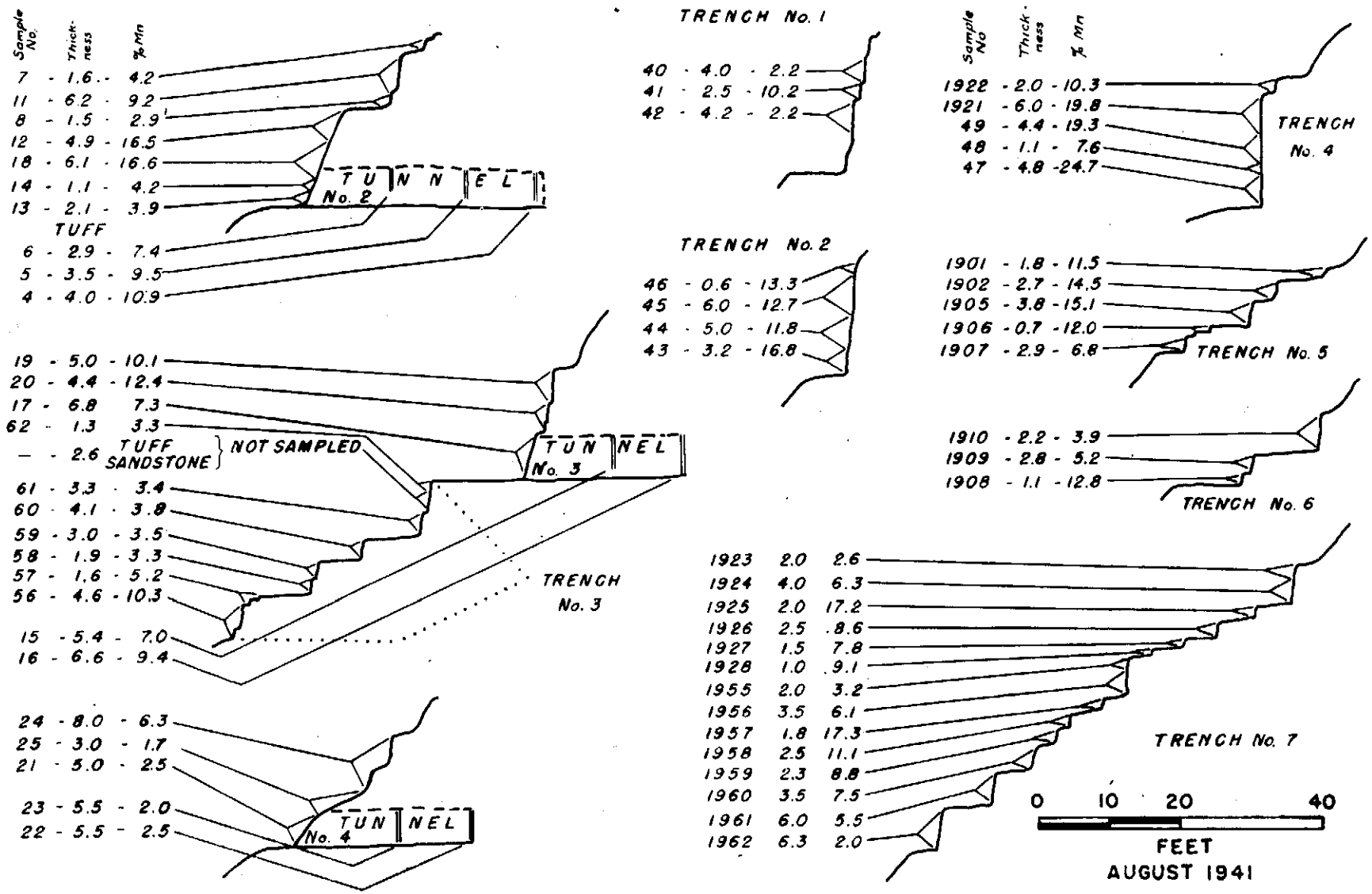

Figure 3. - Tunnel and trench sections, Artillery Peak manganese.

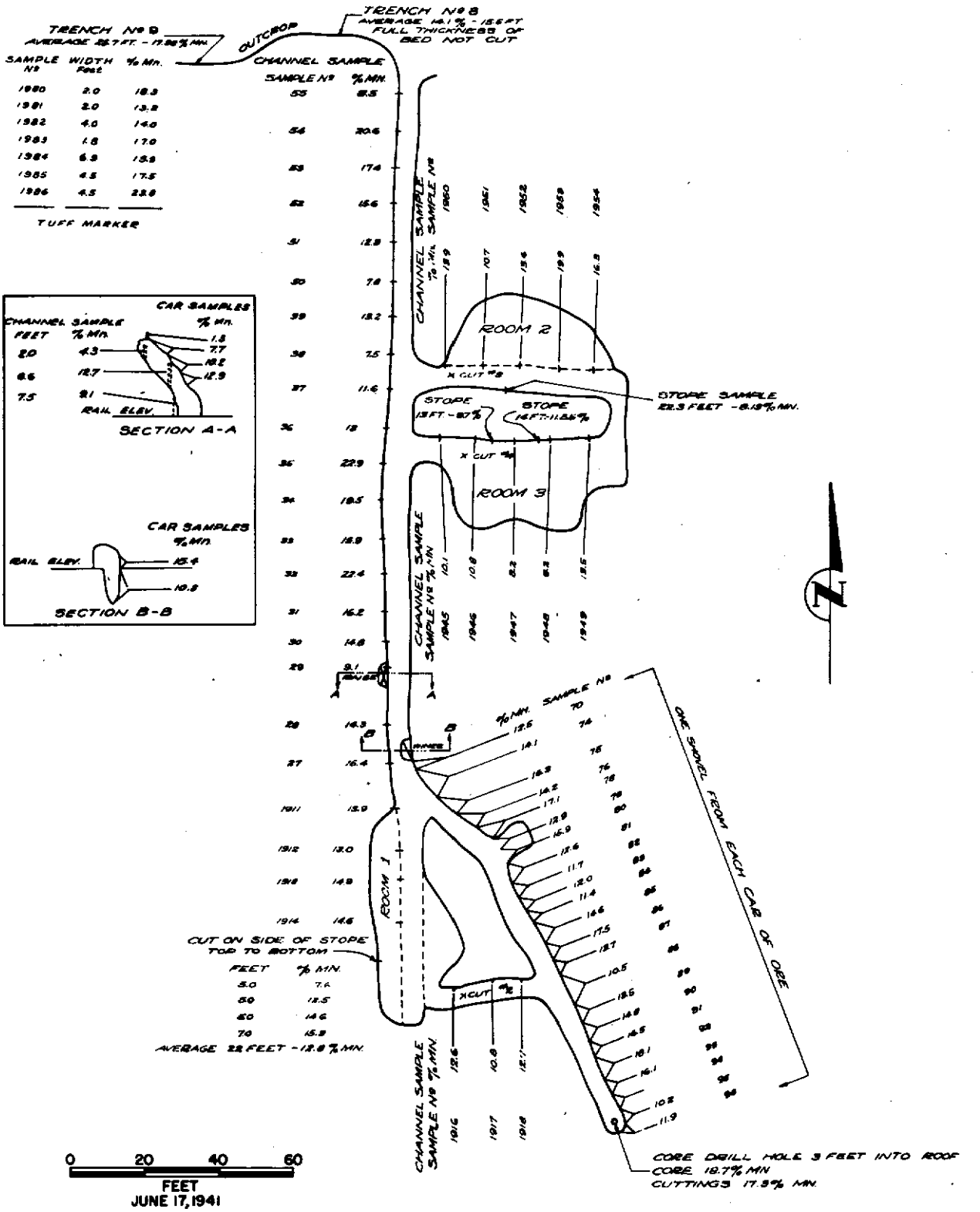

Figure 4. - Assay map of Maggie adit, Artillery Peak manganese.

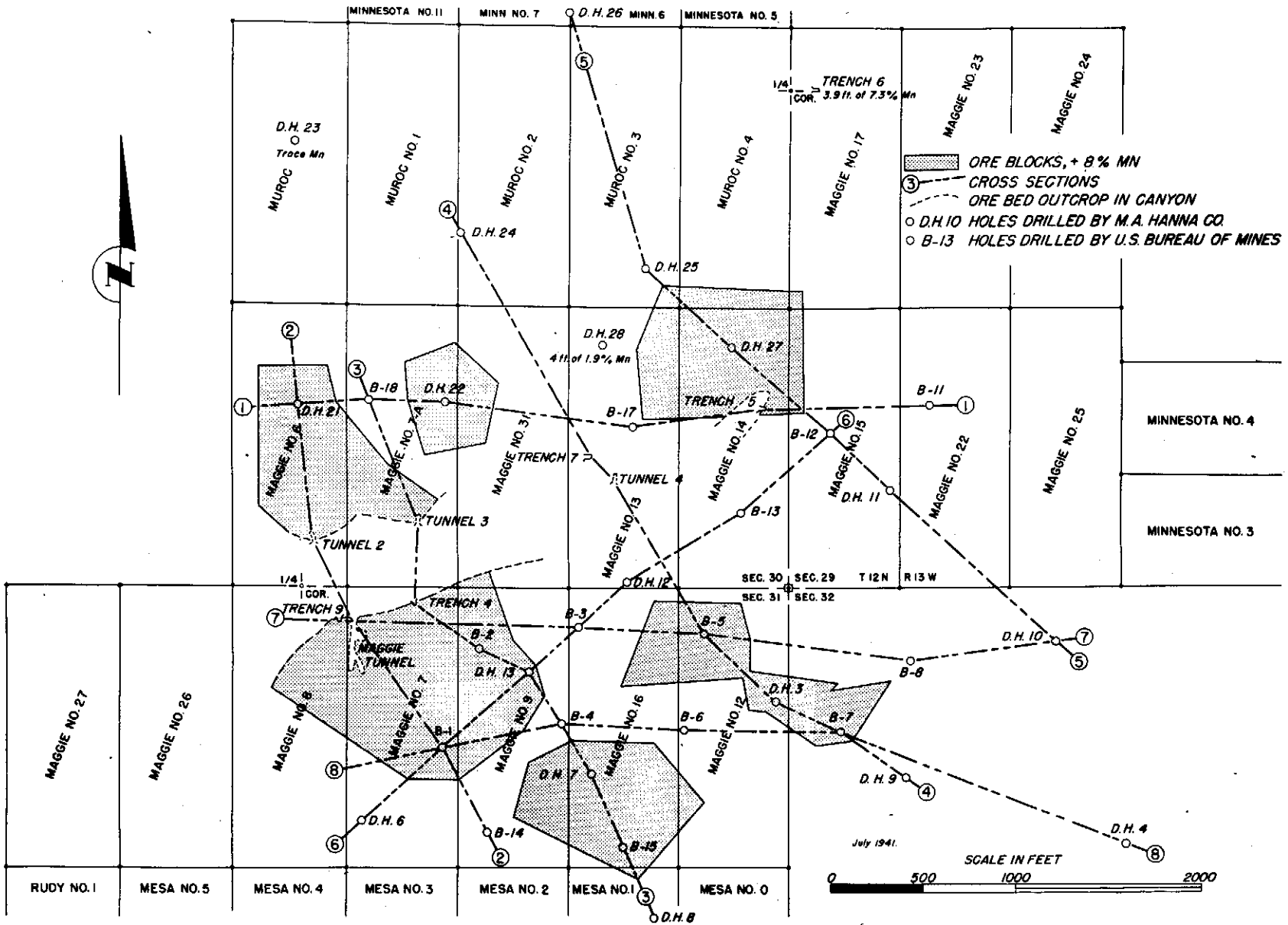

Figure 5. - Ore blocks indicated by drilling, Artillery Peak manganese.

Diamond Drilling - Continued

Item	Article or service	Quantity	Unit	Price
4	Diamond drill-core boring "EX" bit		foot	$2.95
5	Additional diamond-drill core boring as may be ordered:			
	"NX" size		foot	3.35
	"BX" size		foot	3.00
	"AX" size		foot	2.70
	"EX" size		foot	2.45
6	Reaming from "BX" to "NX" size hole for installing "BX" size casing		foot	2.00
	Reaming from "AX" to "BX" size hole for installing "AX" size casing		foot	1.50
	Reaming from "EX" to "AX" size hole for installing "EX" size casing		foot	1.00
7	For cementing, waiting for cement to set, and drilling out cement		foot	1.50
8	Surveying or other extras as ordered by the Bureau of Mines		hour	4.00

Raising and lowering casing for reaming below end of casing was paid for on an hourly basis. Cementing ordered by the resident engineer was paid for by the foot. Fifteen vertical holes totaling 4,316 feet were drilled from the surface. Most of the holes were located halfway between holes previously drilled by the M. A. Hanna Co. (figs. 2 and 5).

All holes were started with an "NX" bit, and most of them were drilled with "NX" or "BX" bits through the basalt overlying the sediments in which the ore occurs. The basalt, which averaged 117 feet in thickness, was very difficult to drill. The dense basalt was so highly fractured that it often "blocked" the bit; after drilling a few inches, the rods would have to be pulled and the bit cleared. Drilling water was frequently lost in the vesicular basalt, and the hole had to be cemented. In this case the cementing was not paid for by the Bureau.

The purpose of starting the holes with the large-size bit was twofold; a better core recovery could be made with a large bit and core barrel, and by starting with a large bit, more sizes of casing were available without reaming.

Casing was always set on top of the ore to avoid dilution of samples. When there was any tendency for the hole to cave, the casing was lowered to the bottom. This was done by raising the casing already in the hole, reaming, and then setting the casing on the bottom, or by casing the existing hole and continuing the drilling with a smaller bit.

Average core recovery in the various formations was as follows: 52 percent in Maggie-type ore, 34 percent in manganese-bearing sediments, and 73 percent in basalt. Average total core recovery for all Bureau drilling was

49 percent, as compared with the 30 percent recovery obtained during previous drilling. Every effort was made to secure a high recovery of sludge. When drilling in Maggie-type hard ore, a total sample (sludge plus core) recovery of 81 percent was secured. The actual weights of core and sludge recovered were divided by calculated weight to determine percentage of recovery of the total sample.

For example: In hole B-1 when drilling from 213 to 218 feet with a "BX" bit, 4.0 feet of core was recovered, weighing 3,565 grams; 5,950 grams of sludge was recovered; weight of total sample was 9,515 grams.

Diameter of "BX" hole is 2-11/32 inches
Diameter of "BX" core is 1-5/8 inches.

For a 5-foot run:

Volume "BX" core is 0.0720 cu. ft.
Volume "BX" sludge is 0.0778 cu. ft.

Average weight of Maggie-type or hard ore is 132 pounds per cu. ft. (See chapter on Specific Gravity.)

Theoretical weight for a 5-foot run:

Core	0.0720 x 132 x 453.6 =	4,311 grams
Sludge	0.0778 x 132 x 453.6 =	4,658 grams
	Total sample	8,969 grams

Hence:

$\frac{3565}{4311}$ = 83 percent core recovery

$\frac{5950}{4658}$ = 128 percent sludge recovery

$\frac{9515}{8969}$ = 106 percent total sample recovery

In these relatively soft formations, part of the core is ground and is recovered in the sludge, as is indicated in the example cited above.

In this drill run the core assayed 11.8 percent and the sludge 10.4 percent manganese. The adjusted average shown in the assay logs was calculated as follows:

Core	3,565 x 11.8 =	42,067
Sludge	5,950 x 10.4 =	61,880
	9,515	103,947

$\frac{103,947}{9,515}$ = 10.9 percent manganese, adjusted average.

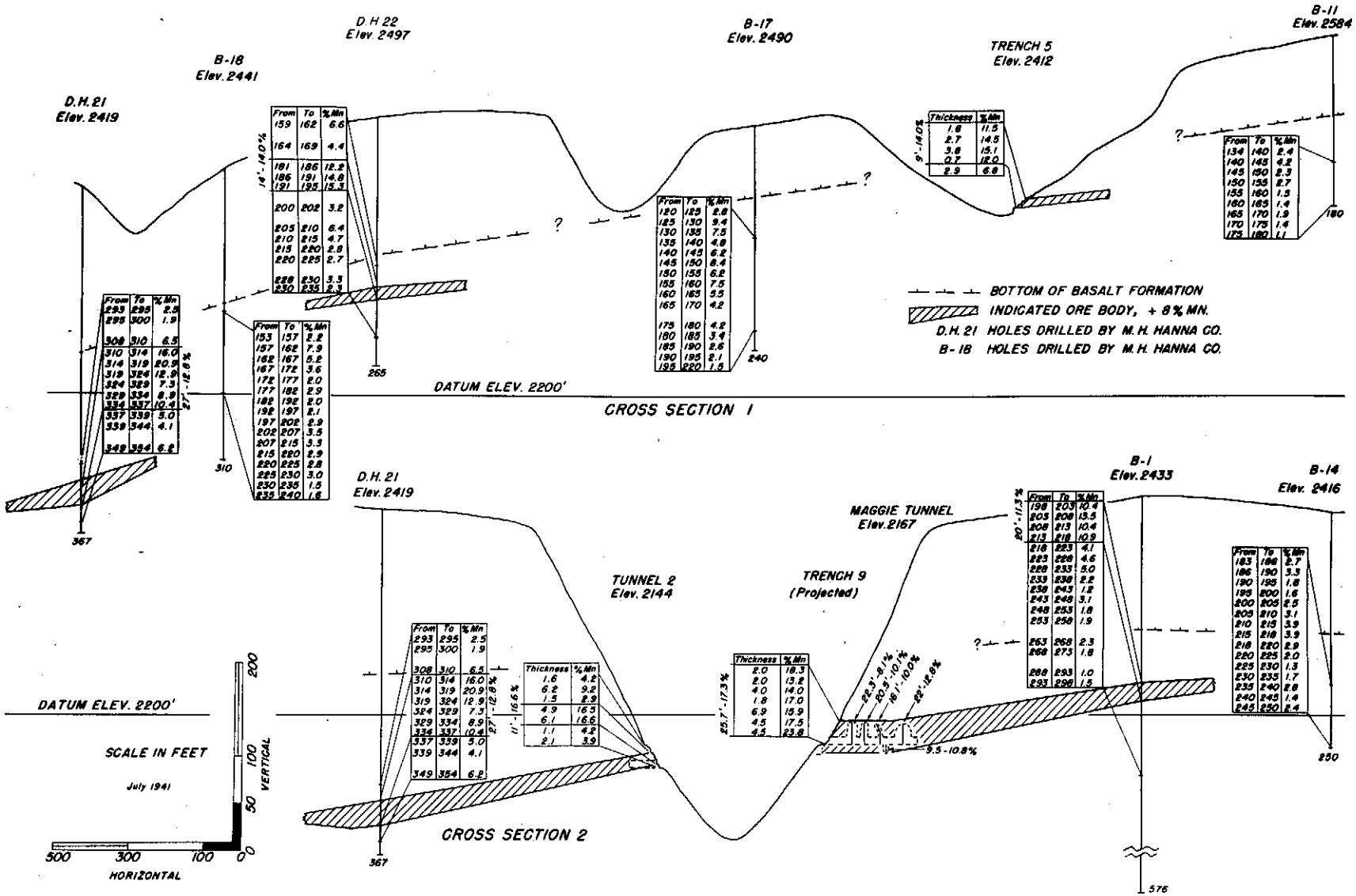

Figure 6. - Cross sections 1 and 2, Artillery Peak manganese.

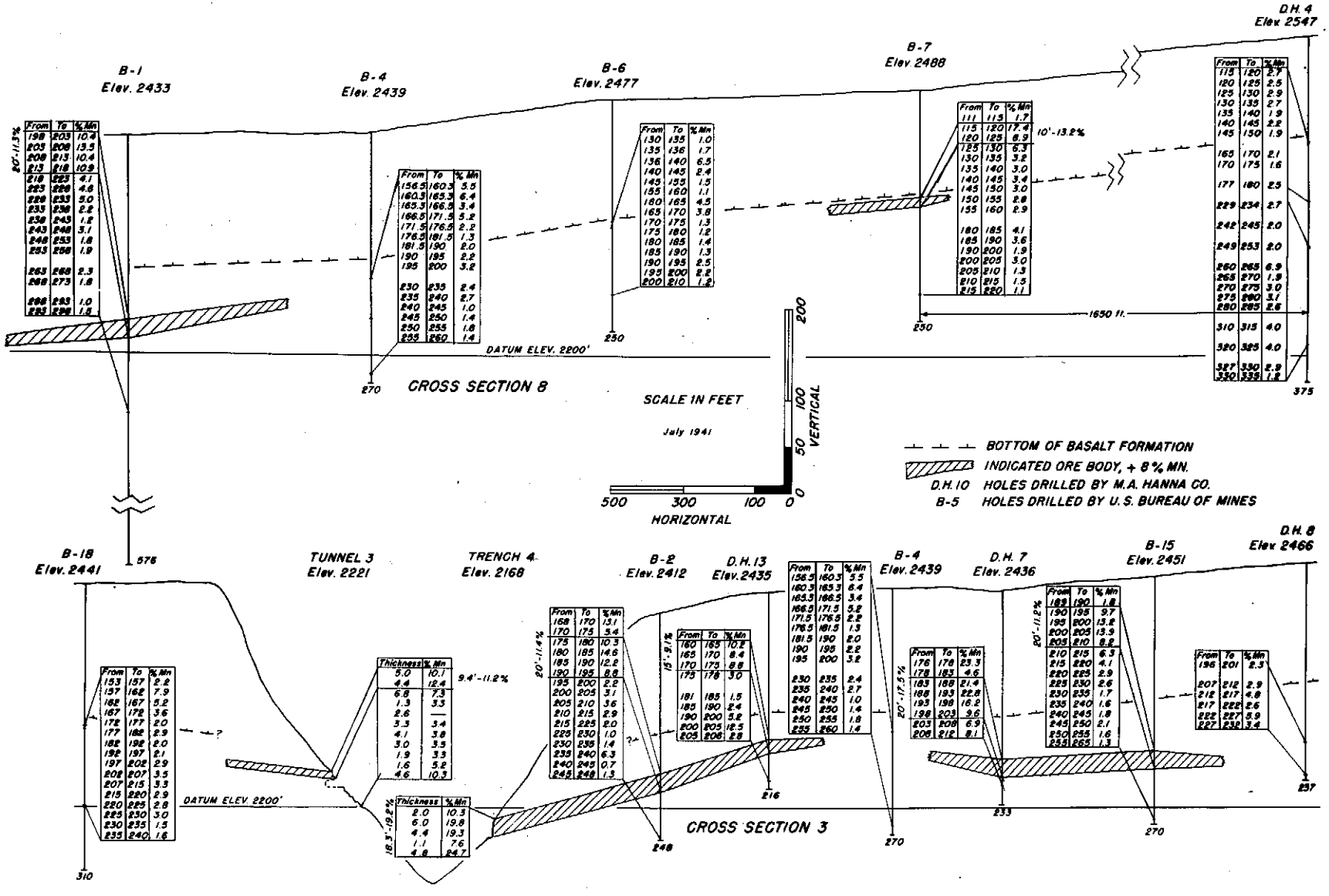

Figure 7. - Cross sections 3 and 8, Artillery Peak manganese.

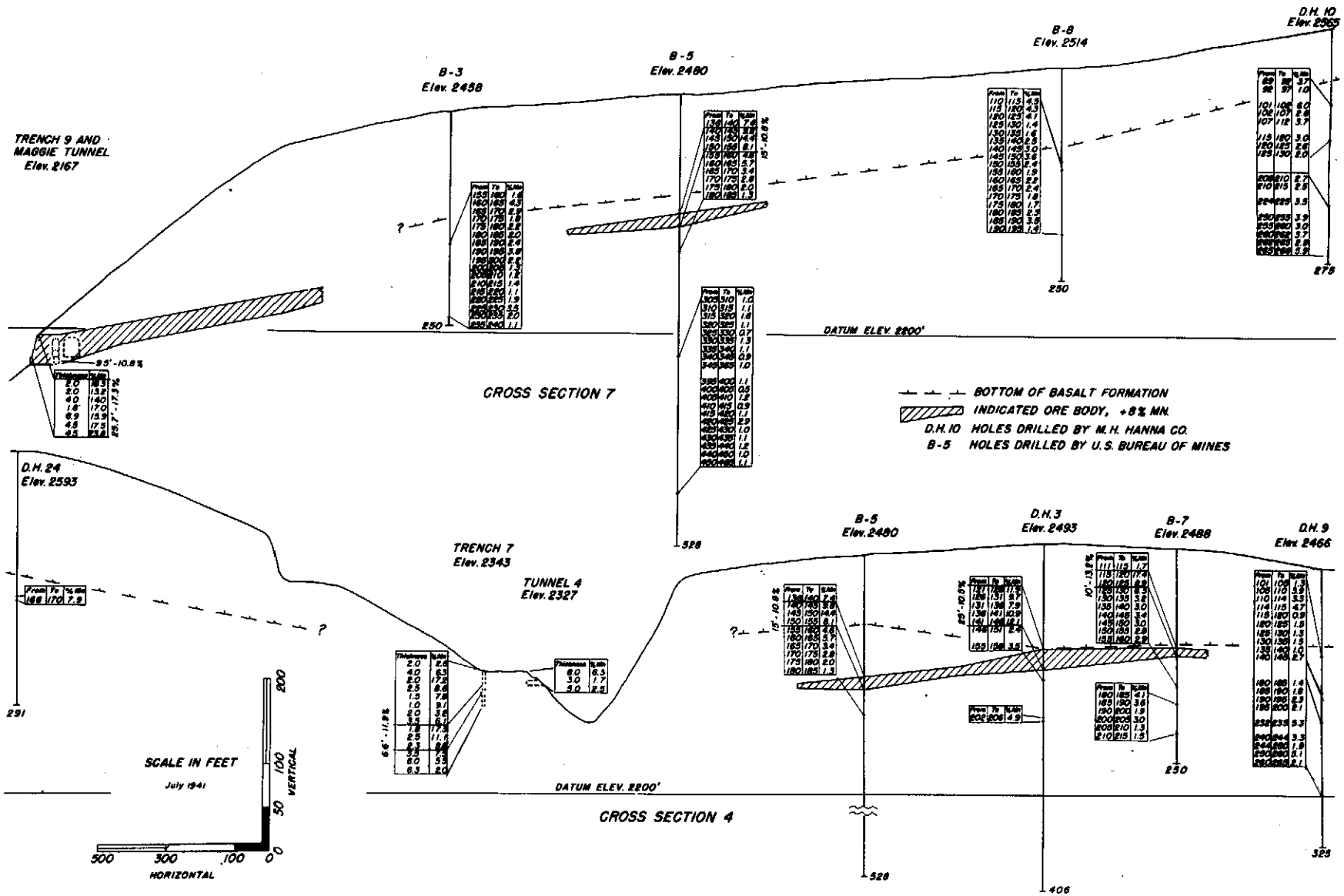

Figure 8. - Cross sections 4 and 7, Artillery Peak manganese.

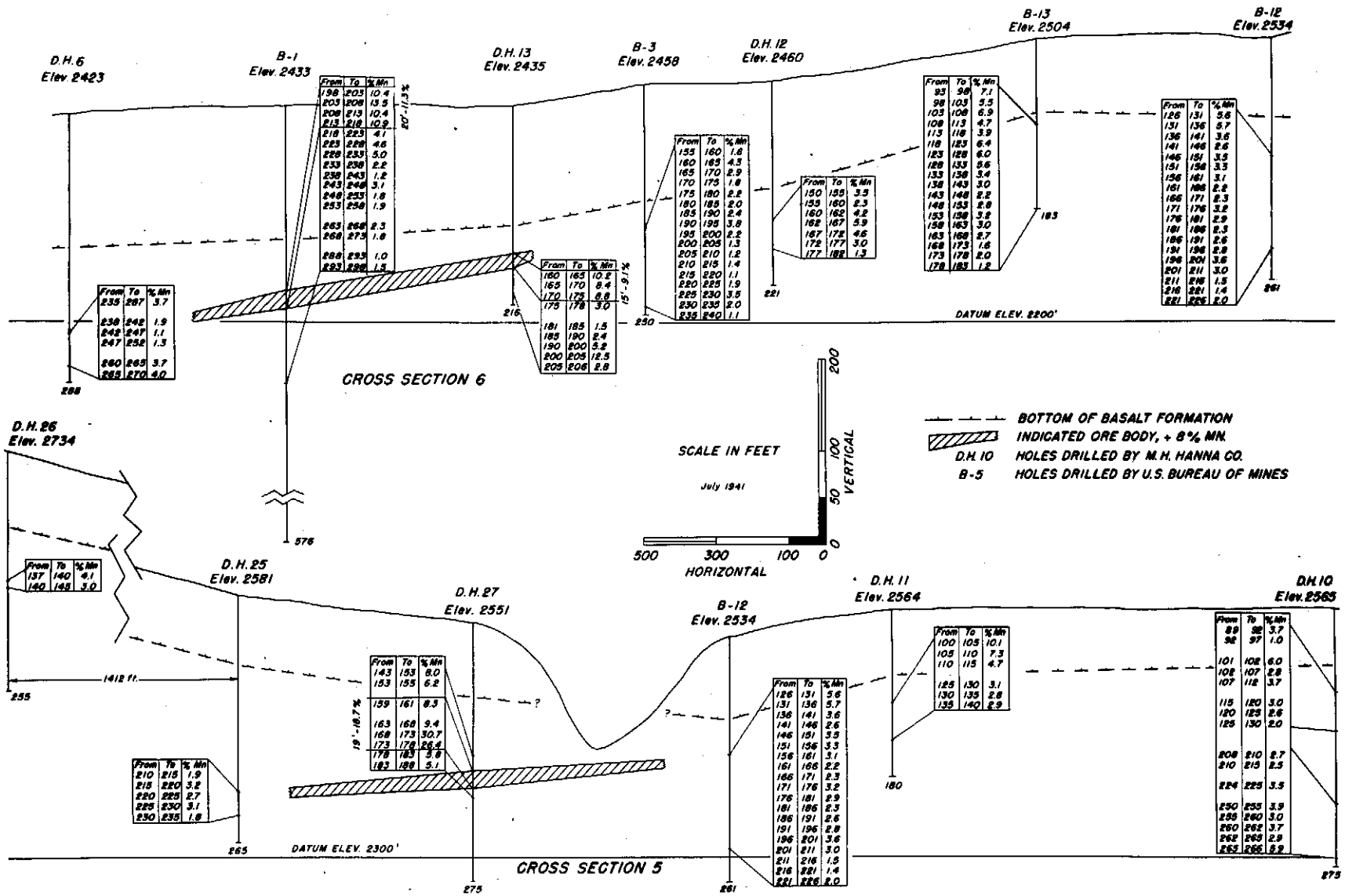

Figure 9. - Cross sections 5 and 6, Artillery Peak manganese.

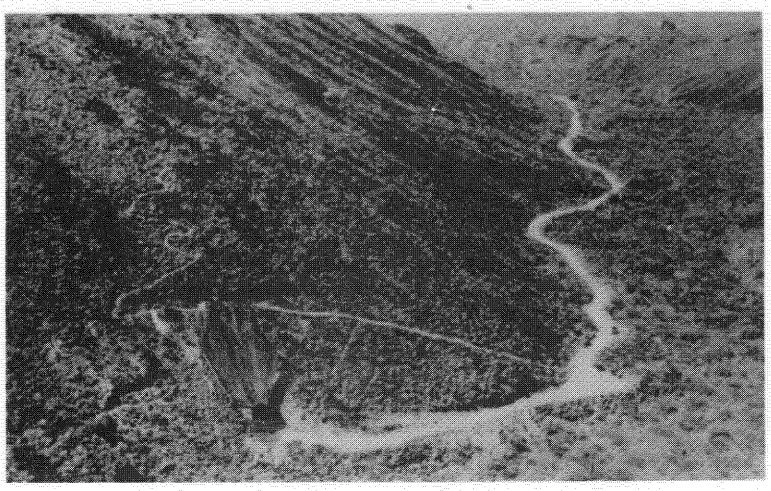

Figure 10. - Maggie adit and ore bin, in Maggie Canyon.

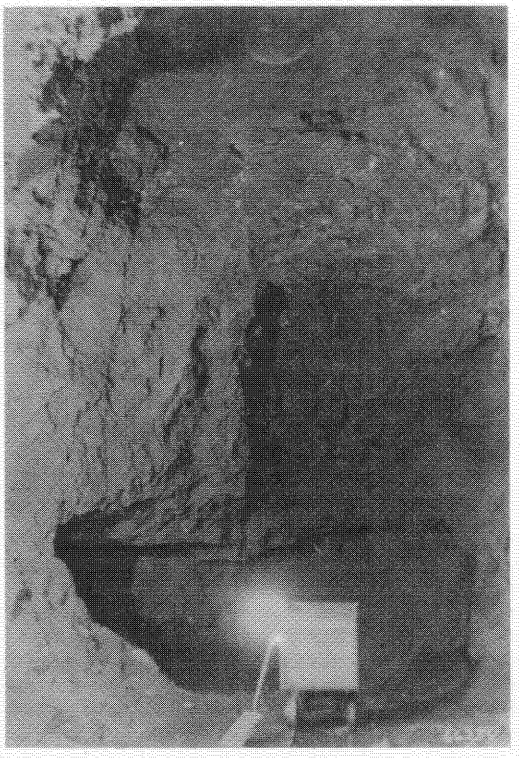

Figure 11. - Experimental mining, room 1, 23 feet high by 25 feet wide.

The M. A. Hanna Co. furnished geologic and assay logs of the holes drilled previous to Bureau investigation. In the assay logs the adjusted average was calculated by using core and sludge combined by volume, based on core recovery.

The logs of the Hanna drill holes within the project area and all holes drilled by the Bureau are in Appendix I (geologic logs) and Appendix II (assay logs).

Figure 5 shows the location of cross sections drawn through drill holes and the vertical sections are shown in figures 6 to 9, inclusive. The vertical scale of these figures necessarily has been exaggerated to show the relatively thin manganese ore bed. For lack of information between drill holes, the plus 8 percent ore bodies are sloped uniformly between holes in which this concentration exists, or are terminated by a pro rata calculation of either a 5-foot mining thickness or a grade cut-off of 8 percent.

Mine Development

Drifting

The existing Maggie adit was 185 feet long with an average cross section of 4.0 by 5.8 feet. After a compressor, water and air lines, and a ventilator were installed the adit was enlarged to 4.8 by 7.3 feet average cross section and track was laid to the face. The southeast drift was started and driven 118 feet S. 21° E. (fig. 4).

A Bureau-owned, double-drum slusher, driven by a gasoline engine and equipped with a crescent-type scraper, was installed near the portal. It was used to move all subsequent development ore to a bin. The bin, composed of timber front and wing walls resting on a stone foundation, was constructed by the Bureau to facilitate the loading of ore into trucks (fig. 10).

The main adit was advanced 60 feet to secure a straight pull with the scraper and to furnish a site for an experimental mining room. Crosscut 2 was driven to provide a safety exit in case the roof became dangerous. Crosscuts 3 and 4 were driven to provide additional room sites for mining. These two crosscuts were connected as a safety measure. In all, 13,650 cubic feet of rock was excavated in advancing development headings a total of 344 feet.

The ore is difficult to drill because it does not have uniform hardness. Irregular masses of hard secondary psilomelane and soft manganese oxide are often cut in the same drill hole, causing the drill steel to stick. Air drills with a powerful rotation are required. Detachable drill bits were used. The best results were secured with side-hole bits because the center-hole bits tended to plug in the softer formations. No timber support was needed in any of the development.

The ground broke well when the ore was uniformly hard. However, some blasting rounds were lost owing to the presence of vugs or solution cavities of considerable size in the hard ore. If one or more holes bottomed in soft, partly cemented ore, the blast would "bootleg" and result in a short advance or a lost round.

Raising

A 4.0- by 7.7-foot raise, started from the back of the drift near the existing winze, was advanced 17 feet. These workings cut the entire thickness of hard ore and penetrated the overlying sandstone formation.

Experimental Mining

After an analysis of all the mining methods that might be used, the room-and-pillar method was selected as the most feasible. The preparation of a room for mining is discussed in the section on Mine Development (p. 11).

No data were available on how the ore would stand in a mine opening larger than a drift. In room 1 slabbing holes were pointed to break not over 2-1/2 feet of ore, and a light charge of dynamite was used to avoid disturbing or breaking the roof. Holes were pointed to form a roof arch, thus providing as much natural support as possible. The ore is somewhat "blocky" and barring down after each blast required considerable time. As the slabbing continued and the room increased in height, a pile of broken ore was allowed to accumulate and the miners worked from the top of this pile. A natural "parting" formed by a band of uncemented low-grade manganese ore was found one foot below the sandstone capping. Between the parting and the sandstone is a thin bed of hard manganese ore that forms an excellent roof. Slabbing was continued until the room reached a maximum width of 25 feet, and a height of 23 feet (fig. 11). The roof in this room did not show any signs of failure. Progress was slow because of the thin slabbing cuts and light charges of dynamite used.

The slusher, used to bank development and slabbing ore in front of the loading chute, also reduced output. It had a rope speed of only 100 feet per minute, requiring 5 minutes for a round trip. This limited production to 24 tons a day. The crescent scraper, designed to move loose sand or gravel on the surface, had poor digging characteristics for underground work. A hoe-type scraper with excellent digging qualities was tried, but the installation still was unsatisfactory because of the slow rope speed. To speed production, track and mine cars were installed and the ore from subsequent operations was hand-shoveled.

After the experience gained in the first room, 8-foot drill steel and heavy slabbing cuts were used in rooms 2 and 3. The heavier charges of dynamite did not result in roof failure and no timber was required. The quantity of ore needed for pilot-mill testing was secured before either of these rooms had been completed. Room 2 was slabbed to a height of 22 feet and a width of 26 feet.

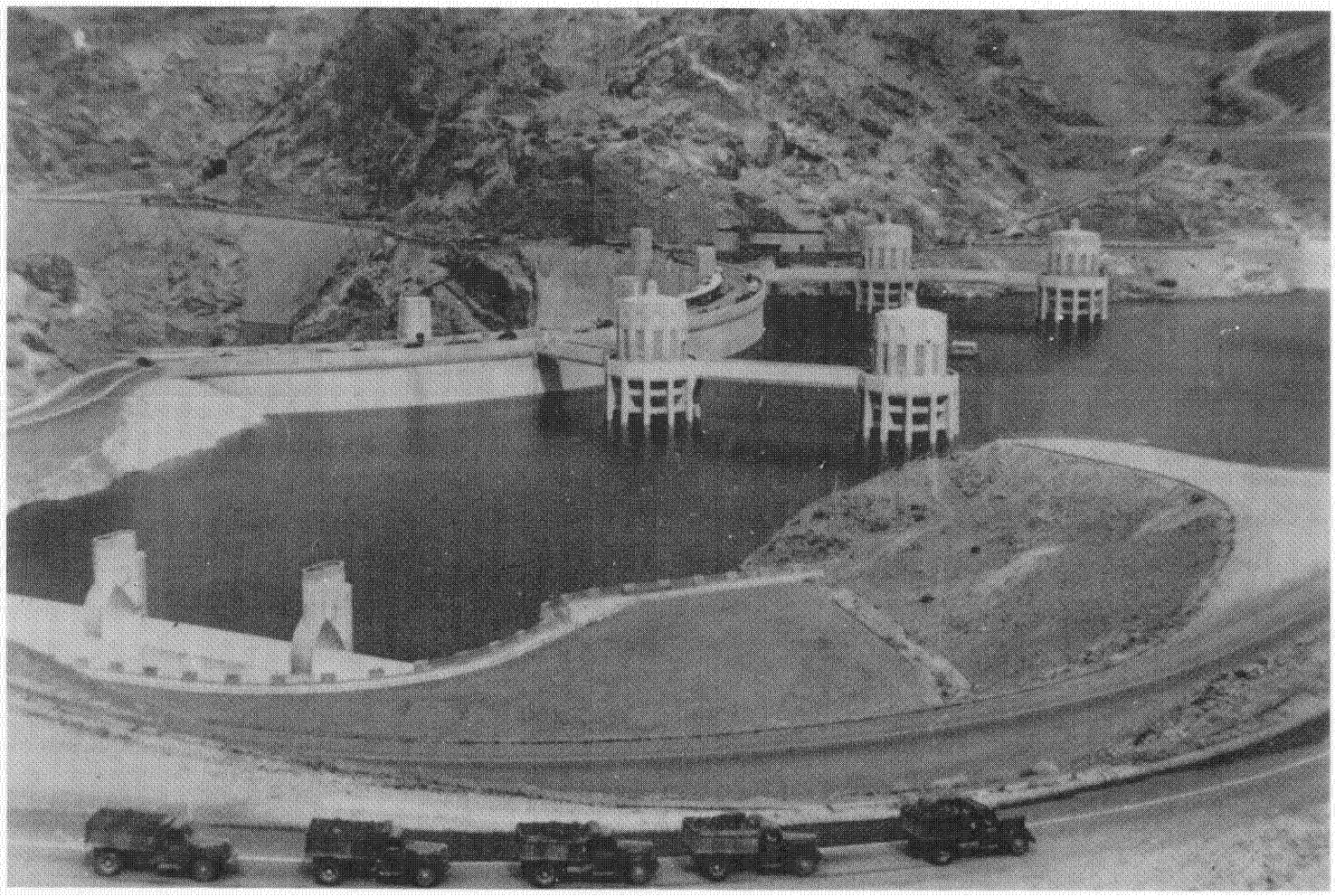

Figure 12. - Trucking Artillery Peak ore to the pilot mill at Boulder City, Nev. Hoover Dam in background.

Approximately 2,510 tons of ore was trucked 160 miles by a contractor to the Bureau's pilot plant at Boulder City, Nev. (fig. 12).

Sampling and Analyses

The trenches, outcrops, and existing and new development headings were sampled by cutting vertical channels 6 inches wide, most of which were 2 inches deep. Samples were caught on canvas and immediately sacked and tagged. Each change in formation within the bed was treated as a separate sample even if the thickness was only 1 or 2 feet. In thicker, uniform beds the sample length was 5 feet, except in a few instances where uniform beds up to 8 feet thick were channeled and treated as a single sample.

At each of the two drills, sludge samples were collected in two specially designed settling tanks. Sludge-settling efficiency tests were conducted that proved the tanks were 99 percent efficient; only a small amount of colloidal material was carried into the return drill-water circuit. Lime was added in the tanks to increase the settling rate.

Duplicate samples were cut from the dried sludge of each run. All core was split; one half was sent for assay, and the other half was given to the M. A. Hanna Co. for its permanent record.

A check on the channel sampling of development headings was obtained by taking one shovelful of sample from each car of development ore.

All samples, except duplicate sludge samples, which were assayed by the Hanna Co., were analyzed by the Bureau at its Reno, Nev., laboratory. In all, 918 samples were taken on the project, divided according to types, as follows:

Diamond-drill core	301
Diamond-drill sludge	404
Trench and outcrop	97
Underground (channel)	85
Composites of car samples	27
Core (hand-drilled)	2
Cuttings (hand-drilled core holes)	2
Total	918

The location, interval, and manganese content of the trench and tunnel samples are shown on figures 3 and 4. The analyses of composite samples, other than car samples, are shown in table 1. The following methods of combining samples were employed: Individual drill-hole samples were made up of proportionate quantities of core and sludge samples based upon the recovered weight of each; composite trench and outcrop samples were combined from constituent samples, which were weighted in proportion to sample lengths; composite stope samples were made up of equal parts of each sample used; and equal parts of the reject of each composite stope and drill hole sample were combined to make up the respective composites of stopes and of drill holes.

TABLE 1. - Composite assays

Location	Percent											
	Mn	Fe	Insol.	CaO[1]	BaO	P	S[2]	Al_2O_3	Pb	Zn	WO_3	Cu
Hole B-1	11.3	1.85	65.62	3.22	3.04	0.061	0.018					
Hole B-2	11.4	2.60	67.80	.70	2.06	.037	.005[3]					
Hole B-3	4.4	2.76	72.56	1.36	.24	.062	.005[3]					
Hole B-4	5.6	3.06	73.68	1.02	.69	.058	.005[3]					
Hole B-5	10.2	2.14	64.24	.95	2.41	.036	.005[3]					
Hole B-6	4.1	1.79	80.66	1.66	.29	.058						
Hole B-7	11.2	1.63	66.76	1.73	1.60	.046	.016					
Hole B-8	4.3	2.41	77.08	1.72	.25	.051	.005[3]					
Hole B-12	5.6	2.91	66.38	3.99	.75	.058	.006					
Hole B-13	6.6	2.28	71.72	.77	1.32	.049	.005[3]					
Hole B-15	10.7	2.75	69.66	.81	1.61	.056	.005[3]					
Hole B-17	6.9	2.49	67.08	.33	5.42	.054	.076					
Comp. Stope 1	12.5	1.27	58.88	2.18	3.37	.054	.008					
Comp. Stope 2	8.2	1.32	69.40	1.49	2.57	.057	.022					
Comp. Outcrop 2	12.3	1.21	68.64	.46	2.85	.056	.018					
Comp. Outcrop 3	11.3	1.20	67.18	1.1	1.98	.055	.005[3]					
Comp. Trench 7	12.0	1.83	60.80	.32	2.54	.066	.005[3]					
Comp. Trench 9	17.3	1.19	53.20	2.2	4.03	.049	.005[3]					
Comp. Stopes 1 and 2	10.4							8.6	0.15	0.05[3]		0.05[3]
Comp. Holes 1,2,5,7, and 15	11.0	2.17	66.88				.005[3]	10.5	.05[3]	.05[3]	0.01[3]	.05[3]
Comp. Holes 3,4,6,8,12,13, and 17	5.4	2.44	72.68					14.0	.05	.05[3]	.01[3]	.05[3]

1/ Soluble in ten percent acetic acid.
2/ Acid soluble.
3/ Less than.

SPECIFIC GRAVITY

The specific gravity of the Maggie-type ore is not uniform. This is to be expected, for the secondary enrichment and the opalization have not been uniform throughout the bed. Owing to the porosity of much of the ore, the standard method of determining specific gravity was not applicable to the determination of weight of ore in place. Eight specimens were selected from the different parts of the mine and the specific gravity of each was determined by the amount of dry sand displaced in a vessel of known volume. The weight of the sand varied from 1.670 to 1.684 grams per cubic centimenter.

Specific-gravity determinations

Weight in grams		Vol. in cc.	Sp. gr.	Cu. ft. /short ton	Remarks
Sample	Displaced Sand	Sample			
4,159	3,253	1,940	2.14	14.9	Average manganese ore.
4,825	3,845	2,280	2.12	15.1	Average ore from stope No. 2
5,182	4,075	2,440	2.13	15.1	Average ore from stope No. 1.
7,887	4,250	2,540	3.11	10.3	Hi-grade ore containing secondary psilomelane.
4,633	3,766	2,240	2.07	15.5	Sandy manganese ore.
4,290	3,510	2,082	2.06	15.5	Sandy, porous manganese ore.
6,820	4,715	2,800	2.44	13.1	Hard, black manganese ore.
5,155	3,780	2,260	2.28	14.0	Hard, black ore from stope No. 2.

From inspection of the tabulation, it would appear that 15 cubic feet per ton would be the average of the ore as mined

METALLURGICAL TESTS

Ore-dressing tests in both Bureau of Mines and commercial laboratories have shown that gravity concentration of this ore is not feasible.

Flotation tests, made in the Bureau of Mines testing laboratory at Salt Lake City, on Artillery Peak ore containing about 12 percent manganese recovered 90.2 percent of the manganese contained in the sand, after grinding to 200-mesh and desliming, or 72.2 percent of the manganese content of the raw ore. The concentrate was 32.2 percent manganese. This concentrate could be raised by repeated recleaning to a grade that sintered to standard ferro grade, but at a prohibitive loss in recovery.

Two hydrometallurgical processes are available that in laboratory tests recover 90 to 95 percent of the manganese: (1) leaching with sulfuric acid and precipitation of manganese metal by electrolysis; (2) leaching with sulfur dioxide followed by crystallization and calcination of manganese sulfate to produce manganese oxide sinter.

In the electrolytic process a preliminary reducing roast is followed by leaching with dilute sulfuric acid, filtering, and decantation, purification of the manganese sulfate to remove interfering elements and electrolysis of the solution to recover virtually pure manganese metal. Artillery Peak ore has been treated successfully by this process in the laboratory, but tests on a larger scale are needed to supply engineering data for plant-design and cost estimates.

Extensive tests of the sulfur dioxide leaching method were made in the pilot plant at Boulder City on ore from the Three Kids deposit in Nevada. This ore is similar to Artillery Peak ore but of higher grade. Much trouble was experience due to certain interfering elements in the ore. These troubles were being reduced by some changes in procedure but the plant was shut down before the new procedure was fully tested.

It is possible that the relative content of the interfering elements can be greatly reduced by flotation treatment, at the same time raising the grade of the feed to the leaching plant and thereby reducing the cost per ton of manganese oxide sinter recovered in the leaching plant.

APPENDIX I

Geologic log - diamond drill hole No. B-1

Artillery Peak Project 303

Logged by Vard H. Johnson, Geological Survey

Depth, feet From	To	Description
0	8	Red, weathered basalt.
8	17.5	Vesicular, blue-gray basalt.
17.5	20	Red sand and basalt. Sand filling in cooling (?) fractures.
20	36	Fractured, gray, vesicular basalt.
36	55	Vesicular basalt, but less shattered.
55	102	Dense basalt grading upward into vesicular basalt.
102	120	Vesicular basalt, except top 15 inches, which is more dense.
120	142	Vesicular basalt grading downward into dense basalt with scattered pores in layers.
142	147	Volcanic sand with red clay matrix.
147	154	Scattered coarse sand in light pink, kaolinized silt matrix.
154	160	No core.
160	170	1 ft. of red, sandy clay core.
170	192.5	Thin-bedded, reddish, bentonitic clays with sandy layers.
192.5	198	3 ft. of laminated pink shales with laminae of MnO interbedded, becoming more sandy toward the bottom. Opal present in cracks. This zone may have contained the upper tuff bed and been crushed during drilling. 2.5 ft. manganiferous sandstone. Top of Maggie beds.
198	203	1 ft. of flaky, thin-bedded manganese and sandstone. 4 ft. of manganiferous sandstone.
203	210	Manganiferous sandstone. Irregular bedding evident but not distinct.
210	213	Same, with small kernels of opal in crevices, and slaty, red clay in one small crack. (Fault?)
213	218	Sandy ore with calcite and opal in fractures.
218	219	Porous, sandy, low-grade ore.
219	220	Sandy, low-grade ore.
220	221	Thin flakes of manganese oxides in spotty clay and sandstone.
221	223	0.5 ft. manganiferous sandstone and 1.5 ft. white to pinkish, tuffaceous (?) sandstone with soft gypsum (?) beds.
223	226.5	2 ft. of sandy core with small spots of manganese oxides and spots of white material resembling pumice. These vary from size of wheat kernel to 3/4 inch across.
226.5	228.3	Sandy ore.
228.5	230	Flaky, lenticular manganese oxides and sandstone.
230	232	Spotty, manganiferous sandstone; bottom of Maggie beds (?).
232	234	White tuff bed with opalized bands. This is the main horizon marker.
234	238	Thin-bedded sandstone with small quantities of manganese oxides.
238	248	Buff sandstones with manganiferous zones.

Geologic log - diamond drill hole No. B-1 (Cont.)

Depth, feet From	To	Description
248	255	Argillaceous sandstone with very faint bedding.
255	260	Fine-grained, argillaceous sandstone alternating with coarse pink to reddish sandstone.
260	267	Interbedded reddish sandstone and bentonitic clays.
267	268.5	Reddish sandstone, manganiferous in lower portion.
268.5	273	Manganese-bearing sandstone.
273	275.5	0.5 ft. manganese-bearing sandstone; 0.5 ft. bentonitic, pink clay; 0.5 ft. manganese ore; and 1 ft. pink sandstone.
275.5	288	Interbedded pink clay and pink sandstone with white grains.
288	293	No core.
293	298	1 ft. red clay; 1.5 ft. pink, manganiferous sandstone; and 2.5 ft. of mixed manganese-bearing and barren sandstone.
298	324	Interbedded red clay and sandstone with occasional manganese-bearing bands 3/8 inch thick.
324	395	Reddish clays, siltstones, and sandstones. One thin manganese-bearing zone between 350 and 355 feet.
395	425	Thin-bedded, reddish clays and silts.
425	428	White tuff, sandy at bottom and chalky at top.
428	450	Thin-bedded, red clay, silts, and sandstones.
450	485	Red clay with occasional manganese stains.
485	523	No core, but sludge indicates red clay, mud, and silt.
523	531	Red clays with manganese stains.
531	576	No core. Sludge indicates red clay, mud, and silt.

Geologic log - diamond drill hole No. B-2

Artillery Peak Project 303

Logged by Vard H. Johnson, Geological Survey

Depth, feet From	To	Description
0	24	Coarsely vesicular, gray basalt.
24	42	Vesicular, gray basalt with smaller vesicles.
42	92	Dense, gray basalt.
92	110	Lavender-colored, vesicular basalt.
110	129	Gray basalt, except 128 to 129 feet, which is purple. Upper portion is finely vesicular, grading intoa more dense phase at 120 feet, where the vesicles appear bedded; then becoming more porous toward the bottom.
129	160	Red to reddish gray sandstone and silts.
160	167	White sandstone with traces of opal.
167	170	Very porous hard ore, resembling finely vesicular basalt. This contains manganese oxides, white and brown sands, and grit.
170	175	Top 3 inches of core contains white fragments of an unknown material (pumice?) up to size of corn kernels, and a large portion of clay. Remainder is of same physical character as 167 to 170 ft.
175	178	Hard, porous ore; manganese oxides and sands.
178	183	Same as above but containing sandy layers with more quartz.
183	185	0.7 ft. of hard ore; 0.9 ft. of silty sand with small blebs of manganese; and 0.4 ft. of hard ore.
185	187	Brown sandstone containing irregularly distributed manganese oxides in uneven layers.
187	190	Same as above but stratification slightly better. Silica content higher, indicated by cherty layers.
190	192	Small band of high-grade manganese represented by 2 inches of core which shows irridescent hematite particles. Remainder is cherty and sandy, low-grade ore.
192	195	Dark to black manganiferous opalized or cherty sandstone. Cracks filled with bentonitic red clay. Manganese content is concentrated in small nodules of nearly pure manganese oxides.
195	200	Opalized and cherty tuff and volcanic sandstone. This is the main tuff horizon marker. The tuff is at the top of the core, probably 195 to 197 ft. Lower portion is buff-colored sandstone with 2 inches of manganese ore at the bottom.
200	205	Weakly manganiferous, bedded sandstone and silts.

Geologic log - diamond drill hole No. B-2 (cont.)

Depth, feet From	To	Description
205	210	Porous, black sand containing a soft, white, fibrous mineral resembling gypsum or fibrous pumice in kernels up to 1/2 inch. Manganese disseminated and also concentrated in thin beds.
210	214	Porous, brown, manganiferous sandstone. Sand sizes are very irregular. Thin layer of tuff represented by 1/2 inch of core between 210 and 211 feet. Pea-sized particles of white pumice (?).
214	216	Manganiferous sandstone, brown to black, with small nodules of semi-clear opal with milky irridescence found in cracks.
216	220	1.5 ft. of thin-bedded buff to brown silts and sands, with thin bands containing manganese oxides; 1.5 ft. of brown, porous sandstone and 1 ft. of porous, black, manganese-bearing sandstone.
220	225	2 ft. of black, porous sandstone with white sand grains. Bedding fair. 3 ft. of silty, brown black sandstone, much less porous than the 2 ft. above.
225	226	3 inches of banded, porous sandstone (brown and black); 9 inches of cocoa-colored siltstone with laminae of manganese oxide.
226	230	Black sandstone with specks of white sand. Slightly manganiferous.
230	238	No core.
238	243	2 inches of white tuff in core lying above 10 inches of reddish sandstone core. 1 ft. of core represents 5 ft. of hole.
243	248	Bedded, red sandstone and siltstone, with traces of manganese oxides. 1 ft. of pea gravel at 245 ft.

All sandstone and siltstone mentioned above are very loosely consolidated.

Geologic log - diamond drill hole No. B-3

Artillery Peak Project 303

Logged by Vard H. Johnson, Geological Survey

Depth, feet From	To	Description
0	30	Vesicular, gray basalt.
30	50	Dense, gray basalt. Occasional layers of pores enlarged to give bedded appearance.
50	82	Dense, gray basalt.
82	100	Basalt; reddish and vesicular in upper portion, to dense and gray with purple tint in lower portion.
100	125	Purple gray basalt.
125	135	Light pink sandstone.
135	141	No core.
141	145	Upper portion of core shows pink sandstone containing manganese oxide; lower portion, pink sandstone and clays with trace of manganese.
145	150	Thin-bedded, barren, pink sandstone with clay partings.
150	155	Core from upper portion consists of opalized and kaolinized tuff with traces of manganese; middle portion, red sandstone; lower portion, pink clay and gouge.
155	160	Upper portion, pinkish sandstone; center portion, manganiferous sandstone and silt; lower portion, hard ore type.
160	165	Soft, earthy, manganiferous sandstone.
165	167.5	Core consists of 2 inches hard ore in sandstone; 1 inch pumiceous, white tuff; and 1.5 inches sandstone with layers of relatively pure manganese oxides.
167.5	170	Upper 1 ft. consists of white pumice; lower portion is white pumice-tuff with only traces of manganese and some brown veinlets of silt.
170	175	Porous, manganese-bearing sandstone with occasional clay partings.
175	180	1.5 ft. of hard, sandy ore; 1 ft. buff-colored silts; 2.5 ft. bedded, coarse sands and silts with varying amounts of manganese oxides.
180	185	Upper 1/2 of recovered core is manganese oxides in coarse sandstone containing pebbles of pumice, 1/8 to 3/4 inch; lower 1/2 of core is low-grade, gray to buff sandstone.
185	190	Bedded, black to buff sandstones. Black portions are coarser and more porous, buff portions are silty and thin-bedded.
190	195	2.5 ft. hard, porous, sandy, black ore. 2.5 ft. of thin beds of black sandstone and buff silts.
195	200	Buff-colored, gritty sandstone with manganiferous layers which may contain as much as 12 percent manganese. Estimated average, 1 to 3 percent manganese.
200	205	No core.

Geologic log - diamond drill hole No. B-3 (cont.)

Depth, feet From	To	Description
205	210	Coarse, porous, dark sandstone with interbedded silty layers. Although the clay is a small portion of the core recovered, it probably represents 60 percent or more of the beds in this zone.
210	215	No core.
215	217.5	0.1 ft. of dark, manganiferous, sandstone core.
217.5	220	No core
220	225	Upper 1/2 of core is sandy manganese ore, lower 1/2 of core is same but of lower grade.
225	230	Upper 1/3 of core contains manganese in a grayish white sandstone, lower 2/3 of core is low-grade manganese ore in sands and silts (very dark).
230	235	Low-grade manganese.
235	240	No core.
240	245	Core consists of 1 inch very low-grade manganese; 3 inches of poorly cemented, coarse sand with clay parting; 6 inches of reddish siltstone (argillaceous); 1 ft. pink sandstone; and 2 ft. of red, soapy clay.
245	250	Coarse, pink sandstone and bentonitic shale.

Geologic log - diamond drill hole No. B-3

Artillery Peak Project 303

Logged by Vard H. Johnson, Geological Survey

Depth, feet From	To	Description
0	30	Vesicular, gray basalt.
30	50	Dense, gray basalt. Occasional layers of pores enlarged to give bedded appearance.
50	82	Dense, gray basalt.
82	100	Basalt; reddish and vesicular in upper portion, to dense and gray with purple tint in lower portion.
100	125	Purple gray basalt.
125	135	Light pink sandstone.
135	141	No core.
141	145	Upper portion of core shows pink sandstone containing manganese oxide; lower portion, pink sandstone and clays with trace of manganese.
145	150	Thin-bedded, barren, pink sandstone with clay partings.
150	155	Core from upper portion consists of opalized and kaolinized tuff with traces of manganese; middle portion, red sandstone; lower portion, pink clay and gouge.
155	160	Upper portion, pinkish sandstone; center portion, manganiferous sandstone and silt; lower portion, hard ore type.
160	165	Soft, earthy, manganiferous sandstone.
165	167.5	Core consists of 2 inches hard ore in sandstone; 1 inch pumiceous, white tuff; and 1.5 inches sandstone with layers of relatively pure manganese oxides.
167.5	170	Upper 1 ft. consists of white pumice; lower portion is white pumice-tuff with only traces of manganese and some brown veinlets of silt.
170	175	Porous, manganese-bearing sandstone with occasional clay partings.
175	180	1.5 ft. of hard, sandy ore; 1 ft. buff-colored silts; 2.5 ft. bedded, coarse sands and silts with varying amounts of manganese oxides.
180	185	Upper 1/2 of recovered core is manganese oxides in coarse sandstone containing pebbles of pumice, 1/8 to 3/4 inch; lower 1/2 of core is low-grade, gray to buff sandstone.
185	190	Bedded, black to buff sandstones. Black portions are coarser and more porous, buff portions are silty and thin-bedded.
190	195	2.5 ft. hard, porous, sandy, black ore. 2.5 ft. of thin beds of black sandstone and buff silts.
195	200	Buff-colored, gritty sandstone with manganiferous layers which may contain as much as 12 percent manganese. Estimated average, 1 to 3 percent manganese.
200	205	No core.

Geologic log - diamond drill hole No. B-3 (cont.)

Depth, feet From	To	Description
205	210	Coarse, porous, dark sandstone with interbedded silty layers. Although the clay is a small portion of the core recovered, it probably represents 60 percent or more of the beds in this zone.
210	215	No core.
215	217.5	0.1 ft. of dark, manganiferous, sandstone core.
217.5	220	No core
220	225	Upper 1/2 of core is sandy manganese ore, lower 1/2 of core is same but of lower grade.
225	230	Upper 1/3 of core contains manganese in a grayish white sandstone, lower 2/3 of core is low-grade manganese ore in sands and silts (very dark).
230	235	Low-grade manganese.
235	240	No core.
240	245	Core consists of 1 inch very low-grade manganese; 3 inches of poorly cemented, coarse sand with clay parting; 6 inches of reddish siltstone (argillaceous); 1 ft. pink sandstone; and 2 ft. of red, soapy clay.
245	250	Coarse, pink sandstone and bentonitic shale.

Geologic log - diamond drill hole No. B-4

Artillery Peak Project 303

Logged by Vard H. Johnson, Geological Survey

Depth, feet From	To	Description
0	28	Weathered basalt and joint-filling sands.
28	40	Dense, gray basalt.
40	60	Old weathered surface at 40 ft. lying on vesicular basalt.
60	62	Weathered zone.
62	80	Vesicular, gray basalt with sand-filled cavities.
80	120	Dense, gray basalt.
120	136	Weathered, dense to vesicular, reddish gray basalt with red clays in cavities.
136	156	Sandy zone, no core.
156	160	Core consists of 1 ft. hard ore; 0.5 ft. brown silt with manganese; and 1 ft. of hard, dark ore.
160	164	Hard, black ore in porous sandstone.
164	165.5	No core, possible fissure in hard ore.
165.5	166.5	Hard, dense ore in silts with narrow stringers of white tuff.
166.5	168.5	Hard ore in sandstone. Manganese oxides in large nodules.
168.5	171.5	White tuff (main marker), with 3 inches of gray brown sandstone at bottom.
171.5	176.5	Weakly manganiferous sandstone.
176.5	185	Low-grade manganiferous sandstone.
185	188	Gray, cherty, spotted sandstone, slightly manganiferous.
188	190	Bedded sandstone with layers of buff and gray sandstone and layers of manganese oxides.
190	195	1 ft. buff sandstone with manganese oxides, and 4 ft. of gray sandstone.
195	200	Coarse and fine, porous, black sandstone, manganiferous.
200	205	Low-grade ore in soft, crumbly sandstone.
205	210	Light brown, cherty sandstone in middle portion; upper and lower portions show loosely cemented, pink sandstone.
210	215	2 ft. of pink clays; 2 ft. pink silts and clays; and 1 ft. slightly manganiferous sandstone.
215	220	Weakly manganiferous sandstone.
220	225	Brown sandstone and silts with a few thin layers of MnO.
225	230	Thin-bedded, brown to red clays and sandy silts with 3 thin zones of manganese.
230	235	Upper portion, red, bentonitic clays; lower portion is manganiferous sandstones.
235	240	Upper portion, manganiferous sandstones; lower portion, reddish clays and silts.
240	245	Well-bedded, reddish clays, silts, and sandstones, with one 6-inch zone containing 1 to 3 percent manganese.
245	260	Pink sandstones and silts with scattered manganese oxides.
260	265	Pink, micaceous sandstones and siltstones, faint bedding.
265	270	Pink sandstone with silty layers.

Geologic log - diamond drill hole No. B-5

Artillery Peak Project 303

Logged by Vard H. Johnson, Geological Survey

Depth, feet From	To	Description
0	29	Basalt.
29	34	Dense, gray basalt.
34	44	Vesicular, gray basalt.
44	47	Weathered, brown basalt.
47	60	Gray basalt, Upper part, vesicular; lower part, dense.
60	114	Vesicular, gray basalt.
114	118	Medium-dense, gray basalt.
118	128	Sand and cavity. At two different horizons diamond bit sank when rotated by hand.
128	136	Basalt fragments and thin-bedded opalite silts and pumice fragments.
136	139	Hard ore with supergene psilomelane (?) coating sand particles of porous sandstone. Ore resembles coke in appearance.
139	140	Hole drilled in side of filled fracture. Walls are hard, porous ore. Fissure filling is dense, silty sandstone with nodules of manganese oxides.
140	143	Hard ore.
143	146	Upper portion is high-grade ore in gray sand. Veinlets of psilomelane are prominent. Lower portion is opalized, white tuff. This is the main marker, judging by the character of the opalized fragments from the core. It is the only dense, opalized tuff in the core recovered from this hole.
146	155	Mostly hard ore type of gray to black, manganiferous sand-stone. Nodules of botryoidal opal were observed in cracks. Secondary psilomelane in veinlets.
155	157.5	Single core fragment shows gray, manganiferous sandstone.
157.5	160	Porous, gray sandstone with manganese.
160	163	Dark gray, porous, manganiferous sandstone.
163	166	Buff sandstone with manganese.
166	170	Porous, gray to black sandstone of hard ore type, but weakly manganiferous.
170	175	Dark gray sandstone with manganese.
175	181	No core.
181	185	1 inch of core at top shows buff-colored sandstone with pumice fragments. Remainder is porous, gray sandstone.
185	210	No core. Bit sand in hole when hand-rotated.
210	215	Bentonitic, red clay with gougy appearance, lower portion thin-bedded.

Geologic log - diamond drill hole No. B-5 (Cont.)

Depth, feet From	To	Description
215	235	1 ft. of soft, light pink sandstone. Remainder is composed of thin-bedded, pink shales, silts, and some sandstone.
235	255	Pink silts and shales.
255	265	Pink silts with very little appearance of bedding.
265	275	Pink, silty clays.
275	285	Pink silts and sandstones with small layer of white marl, which effervesced vigorously in HCl.
285	295	Pink silts.
295	305	No core.
305	310	Bentonitic, red clays with manganese stains.
310	315	As above but with several 1- and 2-inch manganiferous beds.
315	320	Red clays with small particles of manganese oxides disseminated through them.
320	325	Red silts and clay with manganiferous zones at 324 and 325 ft. Former is 1 inch thick and latter is about 3 inches thick.
325	418	No core. Sludge indicates red silts and sand.
418	425	Replaced diamond bit with toothed bit and improved core recovery. Manganiferous, red bentonitic clays. From 418.5 to 421.5 ft., manganese scant and spotty; 421.5 to 425 ft., manganese content concentrated in richer zones. Fragmental condition of the core prohibits detailed logging with definite thickness of beds.
425	435	No core.
435	438	Bedded clays and sands. Top foot is low-grade manganese. Lower 2 ft. contains higher grade manganese. Bottom is barren.
438	443	Uncemented sands with some manganese stains. 1 ft. red clay.
443	528	Uncemented sands and silts.

Geologic log - diamond drill hole No. B-6

Artillery Peak Project 303

Logged by Vard M. Johnson, Geological Survey

Depth, feet From	To	Description
0	23	Vesicular, gray basalt.
23	80	Dense, gray basalt.
80	92	Vesicular, gray basalt capped by a 1-ft. scoriaceous layer.
92	122	Dense, gray basalt.
122	128	Vesicular basalt.
128	130	Pumiceous, white to buff soil and pea gravel.
130	135	Pink sandstone, slightly manganiferous.
135	136	Porous, pink sandstone, some of which has texture similar to coquina.
136	140	Pink silts, grading into earthy, high-grade ore.
140	145	Upper portion, red sandstone with manganese; middle portion, manganiferous, kaolinized pumice; lower portion, soft, white, opalized tuff, nearly barren.
145	155	Reddish black sandstone, slightly manganiferous.
155	160	Porous, dark brown, poorly sorted sandstone.
160	170	Core fragments are very porous, dark brown, manganiferous sandstone.
170	175	Core fragments show manganiferous, pink sandstone.
175	180	Barren, pink silts and sandstones. Sandstone is poorly sorted.
180	185	Bedded, pink sandstone with manganiferous bands.
185	190	Upper portion, manganiferous sandstone; middle portion, barren, pink sandstone; lower portion, silts with traces of manganese.
190	195	Core shows 2 inches of silts and sands as above; 2 inches porous, earthy to sandy ore; 1 ft. manganiferous, black sandstone; 1 ft. pink sandstones and silts with traces of manganese.
195	200	Porous, black manganiferous sandstone.
200	203	Bedded, pink, manganiferous sandstone.
203	206	4 inches of sugary, opalized tuff with traces of manganese; 14 inches coarse, pink sandstone with white grains; 14 inches soft, white, opalized pumice (tuff); and 4 inches pink sandstone.
206	210	Pink manganiferous sandstone.
210	215	Pink sandstone with thin clay beds.
215	230	Thin-bedded, pink sandstones, silts, and soapy clays.

Geologic log - diamond drill hole No. B-6 (cont.)

Depth, feet From	To	Description
230	235	Same, with 2 small, light-colored lenses of sandstone at 231 and 232.5 ft.
235	240	6 inches of manganiferous sandstone; 6 inches light pink sandstone; 6 inches reddish sandstone; 6 inches manganiferous, red clay; 2 ft. of red clays, silts, and sandstone with white pebbles; 6 inches manganiferous clay; and 6 inches of red silts.
240	245	Pink clays and silts with 2 inches of sandstone at bottom.
245	250	Clay and loosely consolidated sandstone

Geologic log - diamond drill hole No. B-7

Artillery Peak Project

Logged by Vard H. Johnson, Geological Survey

Depth, feet From	To	Description
0	2	Caliche.
2	48	Vesicular basalt.
48	60	Dense, gray basalt.
60	89	Vesicular basalt grading downward into dense basalt.
89	111	Dense, blue gray basalt.
111	115	Sandstone and vesicular basalt.
115	125	Hard ore in sandstone.
125	128	Opalized tuff and manganese oxides.
128	135	Hard ore.
135	137	Manganiferous sandstone and opalized tuff.
137	140	Manganiferous sandstone with cherty cement.
140	150	Hard, cherty, manganiferous sandstone with milky, blue opal.
150	155	Soft, friable, manganiferous sandstone.
155	160	No core.
160	165	Dark brown sandstone with opal and small amount of MnO.
165	170	No core.
170	175	Brown sands and pink silts.
175	180	No core.
180	185	Gray, opalized tuff.
185	190	Hard, black sands, manganiferous.
190	195	Pink silts with manganese stains.
195	200	Upper portion, pink silts; lower portion, manganiferous silts and sandstone.
200	205	Upper portion, manganiferous, dark gray silts and sandstones; lower portion, pink silts and sandstone with traces of manganese.
205	210	2 ft. of buff black sandstone with manganese stain in upper foot; 3 ft. black and red silts with cherty cement and manganese.
210	215	18 inches of manganiferous sands and silts; 9 inches pink and red sands and silts; 6 inches manganiferous sandstone; 27 inches pink sandstone.
215	220	2 ft. of manganiferous sandstone and 3 ft. pink sands and silts.
220	240	Pink silts and bentonitic clays.
240	250	Pink silts with white, opalized tuff bed at 248 ft., overlain by thin bed of light gray sand with greenish ochre stain in seam.

Geologic log - diamond drill hole No. B-8

Artillery Peak Project 303

Logged by Vard H. Johnson, Geological Survey

Depth, feet From	To	Description
0	10	Caliche and vesicular basalt.
10	92	Dense, blue gray basalt.
92	95	Pink, white, and black sandstones.
95	100	Pink and cream-colored silts, with buff at 100 ft.
100	105	1 ft. of pink sandstone and 4 ft. hard manganese ore.
105	110	Brown silts and sandstone.
110	115	Hard ore. Pumice fragments at 113 ft.
115	120	Brown manganiferous silts.
120	125	Upper portion, brown manganiferous silts; middle portion, hard, black ore; lower portion, mixed manganese oxides and white, opalized tuff.
125	130	Hard ore with pumice fragments.
130	135	Hard, black and brown sandstone with pumice.
135	140	Hard ore.
140	150	Manganiferous sandstone.
150	155	Manganiferous, black sandstone with pumice fragments.
155	160	Beds in the following sequence; black sandstone, buff sandstone, dark brown sandstone and tuff, and dark brown sandstone.
160	165	1 ft. hard, brown sandstone; and dark-colored, manganiferous sandstone.
165	170	Hard ore.
170	175	Upper half, dark brown, manganiferous sandstone; lower half, hard, brown sandstone.
175	180	6 inches of black and white, manganese-bearing sandstone; 6 inches black sandstone with manganese; 24 inches pink sandstone with manganese stains; 3 inches white tuff; 9 inches buff sandstone; and 12 inches black sandstone.
180	185	Thin-bedded, bentonitic, pink clays and manganese-bearing clays.
185	190	Manganiferous sandstone; silts and opalized tuff.
190	195	Red and manganiferous (black) shales.
195	200	Log of core fragments: 6 inches brown to light gray sands; 3 inches hard, black sandstone with blue gray coating of opal on sand grains; 3 inches brown silts with manganese stains; 3 inches white sandstone and silt containing opalized tuff; and 12 inches buff to pink shales, silts, and sandstone.
200	201	White sandstone with lime cement.
201	216	Pink silts and shales. 3 inch Mn. stained zone at 207 ft.
216	236	Pink silts, shales, and sandstones with 1 ft. of white tuff at 224 ft. White pumice fragments at 222 ft.
236	246	Bentonitic, pink clays and silts.
246	250	2 ft. pink silts with manganese, and 2 ft. pink silts with manganese stains.

Geologic log - diamond drill hole No. B-11

Artillery Peak Project 303

Logged by Charles Hunt, Geological Survey

Depth, feet From	To	Description
0	84	Basalt.
84	100	Conglomerate and grint; pebbles of gneiss, mica schist, and basalt? (basalt may be caving) up to 1 inch in diameter; sandstone pebbles 1/8 inch diameter.
100	134	Conglomerate, grit, and sandstone; pebbles of pumice and light-colored lavas up to 1 inch diameter; considerable pumice fragments at about 107 ft. Considerable tan silt? from 100 to 105 ft.; finely laminated silt and grit from 108 to 114 ft.
134	140	Mostly silt, bottom foot weakly manganiferous. Opal at 140 ft.
140	151.5	Manganiferous sandstone; abundant pebbles of pumice; 4 inches of opal at 141 ft. Sand grains are up to 1/16 inch diameter and manganese occurs as cement between grains, and as coating on grains.
151.5	175	Mostly tan, clayey matrix; occasional sand grains up to 1/16 inch diamter; weakly manganiferous; pumice pebbles like above occur throughout. At 175 ft. is 1-inch core of dense (opalized?) rock, but no tuff structure in it.
175	180	No core.

Geologic log - diamond drill hole No. B-12

Artillery Peak Project 303

Logged by Vard H. Johnson, Geological Survey

Depth, feet From	To	Description
0	80	Vesicular basalt to 18 ft., underlain by dense, gray basalt.
80	86	Porous basalt with hematite stains.
86	91	Conglomeratic sandstone (red, gray, and yellow).
91	106	Bright red silts grading downward into gray brown sandstone. Pumice fragments occur at 100 ft. Cross bedding at 99 ft.
106	111	Light buff sandstone composed of volcanic sand. Between 110 and 111 ft. is a 3-inch piece of felsitic rhyolite with flat sides suggesting a small dike or angular boulder.
111	116	Pea gravel conglomerate with fragments of quartz and pumice.
116	121	3 ft. of buff pink sandstone with pumice; 2 ft. gray, mottled sandstone with pumice.
121	126	Pea gravel conglomerate.
126	131	Buff-colored silts with manganese oxides.
131	136	4 ft. of manganiferous, gray conglomerate; 1 ft. dark, manganiferous sandstone.
136	141	Gray conglomerate with one 4-inch piece of biotite granite.
141	146	Mottled, gray gravel with weathered feldspar.
146	151	Brown and black, conglomeratic sandstone.
151	156	Brown and black sandstone with angular, gray lava pebbles.
156	171	One piece of dark gray sandstone with manganese.
171	176	Dark gray sandstone with fragments of pumice and granite.
176	181	Brown, silty sandstone grading into white sand with cement of manganese oxide.
181	186	Gray sandstone; white sands with manganiferous cement; 1 ft. of loose, brown sand.
186	191	Upper portion, gray brown sandstone; lower portion, manganiferous, silty sandstone.
191	196	No core.
196	201	Brown black, manganiferous sandstone.
201	206	No core.
206	211	Upper portion, manganiferous sandstone and tuff; lower portion, opalized tuff.
211	216	Single piece of opalized tuff.
216	221	No core.
221	226	Brown sandstone with traces of manganese at 226 ft.
226	231	Manganiferous sandstone grading downward into pale pink sandstone.
231	236	Uncemented sands, red shales, and gray sandstone.
236	246	Pink sandstones and shales with showings of pumice.
246	254	Pink silts, clays, and sandstone.
254	255	Thin-bedded, red and greenish gray clays. Gray clay contains weathered tuff.
255	256	Light buff sandstone.
256	261	Red and brown silts, clays, and sandstone.

Geologic log - diamond drill hole No. B-13

Artillery Peak Project 303

Logged by Charles Hunt, Geological Survey

Depth, feet From	To	Description
0	81	Basalt.
81	88	Conglomerate and sandstone.
88	92.5	No core. (Sludge assays 0.7 percent manganese).
92.5	106	Manganiferous sandstone; pumice pebbles at 101 ft.
106	106.5	Tuff. Top 4 inches manganiferous.
106.5	118	Manganiferous silt; top foot weakly manganiferous; pumice pebbles at 114 and 117 ft.; opal at 119 ft.; a few 1-inch partings of gritty ore.
118	138	Manganiferous sandstone and silts. Opal vein at 132 ft.; pumice pebbles at 137 ft.
138	143	No core.
143	163	Sandy beds, weakly manganiferous; clean, hard quartzite (silica cemented ?) at 158 ft. Top 5 feet very fine-grained; pumice pebbles at top.
163	168	No core.
168	173	Weakly manganiferous, fine-grained sandstone, friable.
173	183	No core.

Geologic log - diamond drill hole No. B-14

Artillery Peak Project 303

Logged by Charles Hunt, Geological Survey

Depth, feet From	To	Description
0	126	Basalt.
126	166	Red sandstone.
166	176	No core.
176	183	Top half of core sandy, red, weakly and spottily manganiferous; bottom half is shaley.
183	204	Manganiferous sandstone. Top 2 ft. weakly manganiferous and opalized; 4 inches of barren, red sandstone at 202 and 203 ft. A few thin (1/4 inch), barren partings are mostly fine-grained.
204	206	Fine-grained, red sandstone, mostly barren.
206	219	Manganiferous sandstone. 1 ft. of barren, opalized, red sandstone at 208 ft.; numerous other very thin opalized beds; fine-grained beds from 213 to 214 ft.
219	220	Dense, white bed with black crystals, probably tuff.
220	250	Manganiferous, sandy beds; fine-grained beds containing pumice pebbles from 230 to 235 ft.; mostly barren, red sandstone at 240 to 241 ft.; thin, opalized bands and thin, nearly barren beds are common.

Geologic log - diamond drill hole No. B-15

Depth, feet From	To	Description
0	133	Basalt.
133	144	Red conglomerate.
144	145	White tuff.
145	155	No core.
155	185	Weakly manganiferous silt, crumbly, probably containing clay.
185	190	Weakly manganiferous red clay, slightly gritty; gray clay at 189 to 190 ft.
190	220	Very fine-grained, manganiferous sandstone; 1 inch opal layer and weakly manganiferous silt at 208 ft.
220	225	Only 1 ft. of core; top 1/3 is weakly manganiferous, red sandstone; white tuff at middle; bottom 1/3 belongs to underlying unit.
225	236	Manganiferous sandstone.
236	250	Mostly barren, red sandstone. Contains a few weakly manganiferous layers 1 to 2 ft. thick.
250	270	Weakly manganiferous sands and silts.

Geologic log - diamond drill hole No. B-17

Artillery Peak Project 303

Logged by Vard H. Johnson, Geological Survey

Depth, feet From	To	Description
0	106	Basalt.
106	110	4 ft. of buff sandstone and silt with thin (3 inches of core) layer of scaly, secondary manganese oxides, opal, and sand.
110	115	Upper portion, buff sands and silts; lower portion, pebbly sandstone with arkosic sandstone containing biotite at 115 ft.
115	120	Volcanic sandstone (lavender color).
120	125	Earthy, manganiferous silts.
125	140	No core, Sludge indicates manganiferous silts.
140	145	Hard, manganiferous sandstone with stringers of tuff. Maggie beds.
145	170	No core. Sludge indicates soft, manganiferous sandstones.
170	175	Gray, manganese-bearing sandstone.
175	190	Hard, porous sandstone with manganese oxide cement and crusts on white sand grains.
190	195	No core.
195	200	2 ft. of buff sandstone with manganese stains; 1 ft. laminated tuff and silt with manganese oxides; 2 ft. yellow brown tuff. (Main Marker).
200	205	No core.
205	210	Core recovered is white tuff and lavender sandstone.
210	215	Core recovered is dark gray sandstone.
215	220	Buff to gray, thin-bedded sandstones and silts with manganese showings.
220	225	Light-colored sandstone with disseminated manganese oxide flakes.
225	230	Top portion, pink silt with pumice fragments; remainder, thin-bedded, red clays and pinkish white sandstone.
230	240	White sandstone, buff silts, and red clays.

Geologic log - diamond drill hole No. B-18

Artillery Peak Project 303

Logged by Charles Hunt, Geological Survey

Depth, feet From	To	Description
0	144	Basalt.
144	145	Fault gouge (?).
145	153	Impure limestone.
153	157	Slightly manganiferous, pink sandstone and tuff.
157	238	Manganiferous sandstone. Few pumice pebbles at 182 ft.; very fine-grained sandstone at 167 to 177 ft.; 10 inches of barren sandstone at 184 ft.
238	245	Barren, fine-grained, red sandstone.
245	246	Barren, gray grit.
246	250	White tuff in 2 beds separated by 4 inches of pink sandstone.
250	260	Practically barren, fine-grained, pink sandstone.
260	285	Laminated, fine- and coarse-grained, pink sandstone, mostly barren but weakly manganiferous from 260 to 278 ft.
285	290	Only 6 inches of core. Opal, in part, white; may represent a tuff bed, but shard structure was not visible.
290	310	Mostly clay and very fine-grained, red sandstone, practically barren.

Geologic log - diamond drill hole No. DH-3

Artillery Peak deposit

Logged by Benj. N. Webber M. A. Hanna Co.

Depth, feet From	To	Description
0	11	Caliche and caliche-cemented basalt debris.
11	120	Vesicular basalt, grading downward into dense, hard basalt.
120	151	Hard, porous, arkosic sandstone; manganiferous.
151	158	Sandstone, weakly manganiferous.
158	198	Soft, gray, friable sandstone.
198	202	Tuff, white to gray.
202	208	Sandstone, weakly manganiferous.
208	211	Manganese-stained tuff.
211	226	Sandstone.
226	228	Tuff, slightly manganiferous.
228	231	Tuff, slightly sandy.
231	233	Friable sandstone; trace of manganese.
233	244	Red, laminated tuff; trace of manganese.
244	246	Sandstone.
246	252	Red tuff.
252	254	Montmorillonite.
254	281	Tuff with sandstone partings.
281	300	Tuff showing rhythmic deposition of thin manganese bands.
300	349	Tuff, weakly manganiferous.
349	361	Sandstone with tuff partings.
361	366	Tuff, weakly manganiferous.
366	381	Sandstone and tuffaceous sandstone.
381	404	Tuff and arenaceous tuff, slightly manganiferous.
404	406	Sandstone.

Geologic log - diamond drill hole No. B-18

Artillery Peak Project 303

Logged by Charles Hunt, Geological Survey

Depth, feet From	To	Description
0	144	Basalt.
144	145	Fault gouge (?).
145	153	Impure limestone.
153	157	Slightly manganiferous, pink sandstone and tuff.
157	238	Manganiferous sandstone. Few pumice pebbles at 182 ft.; very fine-grained sandstone at 167 to 177 ft.; 10 inches of barren sandstone at 184 ft.
238	245	Barren, fine-grained, red sandstone.
245	246	Barren, gray grit.
246	250	White tuff in 2 beds separated by 4 inches of pink sandstone.
250	260	Practically barren, fine-grained, pink sandstone.
260	285	Laminated, fine- and coarse-grained, pink sandstone, mostly barren but weakly manganiferous from 260 to 278 ft.
285	290	Only 6 inches of core. Opal, in part, white; may represent a tuff bed, but shard structure was not visible.
290	310	Mostly clay and very fine-grained, red sandstone, practically barren.

Geologic log - diamond drill hole No. DH-3

Artillery Peak deposit

Logged by Benj. N. Webber M. A. Hanna Co.

Depth, feet From	To	Description
0	11	Caliche and caliche-cemented basalt debris.
11	120	Vesicular basalt, grading downward into dense, hard basalt.
120	151	Hard, porous, arkosic sandstone; manganiferous.
151	158	Sandstone, weakly manganiferous.
158	198	Soft, gray, friable sandstone.
198	202	Tuff, white to gray.
202	208	Sandstone, weakly manganiferous.
208	211	Manganese-stained tuff.
211	226	Sandstone.
226	228	Tuff, slightly manganiferous.
228	231	Tuff, slightly sandy.
231	233	Friable sandstone; trace of manganese.
233	244	Red, laminated tuff; trace of manganese.
244	246	Sandstone.
246	252	Red tuff.
252	254	Montmorillonite.
254	281	Tuff with sandstone partings.
281	300	Tuff showing rhythmic deposition of thin manganese bands.
300	349	Tuff, weakly manganiferous.
349	361	Sandstone with tuff partings.
361	366	Tuff, weakly manganiferous.
366	381	Sandstone and tuffaceous sandstone.
381	404	Tuff and arenaceous tuff, slightly manganiferous.
404	406	Sandstone.

Geologic log - diamond drill hole No. DH-4

Artillery Peak deposit

Logged by Benj. N. Webber M. A. Hanna Co.

Depth, feet From	To	Description
0	12	Caliche and caliche-cemented basalt fragments.
12	66	Dense basalt.
66	109	Vesicular basalt.
109	115	Opalite with sandstone partings.
115	150	Manganiferous sandstone, generally porous.
150	165	Sandstone, coarse-grained and friable.
165	175	Moderately coarse-grained sandstone, grains coated with MnO_2.
175	180	Sandstone.
180	185	Sandstone with tuff partings.
185	204	Fine-grained massive tuff, with manganiferous partings near bottom.
204	208	Tuffaceous sandstone.
208	214	Montmorillonite (?).
214	218	Sandstone.
218	229	Red, arenaceous tuff.
229	240	Arenaceous tuff, weakly manganiferous.
240	242	Sandstone.
242	253	Tuff, slightly manganiferous.
253	257	Coarse sandstone, rock fragments, and cemented pea gravel.
257	300	Tuff, partly manganiferous.
300	305	Sandstone.
305	350	Arenaceous tuff, weakly manganiferous.
350	355	Sandstone.
355	375	Tuff with sandstone partings.

Geologic log - diamond drill hole No. DH-6

Artillery Peak deposit

Logged by Benj. N. Webber M. A. Hanna Co.

Depth, feet From	To	Description
0	10	Caliche.
10	143	Vesicular basalt with occasional pockets of volcanic ash.
143	195	Conglomerate, sandy at top, grading downward to larger pebbles (Temple Bar conglomerate).
195	196	Montmorillonite (zeolitic alteration of tuff).
196	220	Arenaceous tuff, contains some calcareous aggregates.
220	230	Light gray, fine- to medium-grained sandstone.
230	235	Sandstone with tuff partings.
235	237	Arkosic sandstone, manganiferous.
237	238	Barren sandstone.
238	252	Manganiferous sandstone with opalite partings.
252	259	Sandstone.
259	270	Sandstone, manganiferous.
270	280	Barren sandstone.
280	288	Arkosic sandstone.

Diamond drill hole No. DH-7

Depth, feet From	To	Description
0	20	Surface mantle.
20	136	Basalt, alternating vesicular and dense.
136	142	Arenaceous tuff, with thin, limy partings.
142	144	Limestone, contains altered tuffaceous material.
144	155	Arenaceous tuff.
155	156	Hard, arkosic sandstone.
156	176	Arenaceous tuff.
176	178	Sandstone composed largely of glass fragments; manganiferous.
178	198	Manganese in arkosic sandstone. Slaggy appearance.
198	212	Sandstone with opalite partings; manganiferous.
212	221	Sandstone.
221	223	Arenaceous tuff.
223	226	Sandstone, weakly manganiferous.
226	233	Tuff with trace of manganese.

Geologic log - diamond drill hole No. DH-8

Artillery Peak deposit

Logged by Benj. N. Webber M. A. Hanna Co.

Depth, feet From	To	Description
0	4	Caliche.
4	131	Basalt, alternating vesicular and dense.
131	147	Tuff, composed largely of altered glass fragments.
147	148	Conglomerate of limestone and gneiss pebbles.
148	165	Tuffaceous sandstone, $CaCO_3$ cement.
165	178	Friable sandstone, tuffaceous or silty toward bottom.
178	188	Tuff with $CaCO_3$ segregations.
188	193	Arenaceous tuff.
193	194	Limestone with tuffaceous inclusions.
194	196	Opalite intercalated with thin beds of limy tuff.
196	201	Tuffaceous sandstone, weakly manganiferous.
201	207	Arkosic sandstone with SiO_2 cement. Opalite partings.
207	232	Arkosic sandstone, somewhat porous, weakly manganiferous.
232	237	Devitrified opalite, contains considerable ash and glass.
237	247	Tuffaceous sandstone, trace of manganese.
247	257	Intercalated arkosic and tuffaceous sandstone.

Geologic log - diamond drill hole No. DH-9

Artillery Peak deposit

Logged by Benj. N. Webber M. A. Hanna Co.

Depth, Feet From	To	Description
0	14	Fractured basalt with caliche seams and cement.
14	66	Vesicular basalt.
66	93	Dense basalt.
93	96	Sandstone.
96	101	Intercalated beds of tuff and opalite.
101	104	Tuff, some large volcanic glass shards; manganese stained in part.
104	114	Arkosic sandstone, weakly manganiferous.
114	120	Devitrified cemented volcanic glass particles; trace of manganese.
120	137	Tuffaceous and arkosic sandstone, slightly manganiferous.
137	145	Sandstone composed of quartz and volcanic glass grains.
145	170	Indurated, gray sandstone, manganese stained to weakly manganiferous.
170	175	Arenaceous tuff.
175	191	Friable sandstone, manganese stained to weakly manganiferous.
191	193	Tuffaceous sandstone.
193	195	Conglomerate, small pebbles of volcanic glass.
195	199	Red, arenaceous tuff.
199	225	Mottled, buff sandstone.
225	265	Tuff, weakly manganiferous. (Chapin Bed)
265	325	Tuff with sandstone partings.

Geologic log - diamond drill hole No. DH-10

Artillery Peak deposit

Logged by Benj. N. Webber M. A. Hanna Co.

Depth, feet From	To	Description
0	60	Vesicular basalt. Practically no caliche on surface.
60	67	Fine-grained, calcareous sandstone.
67	68	Red limestone and black silica.
68	72	Sandstone.
72	77	Gray, arenaceous tuff, with considerable mica.
77	89	Gray, porous, arkosic sandstone.
89	92	Manganiferous, arkosic sandstone.
92	93	Opalite.
93	101	Manganiferous, arkosic sandstone.
101	112	Sandstone, manganiferous.
112	155	Gray, porous sandstone; manganese tenor decreasing downward.
155	160	Variegated sediments, quartz sand and limestone, manganese stained.
160	215	Tuff with manganese partings, occasional sandstone layers.
215	230	Manganiferous tuff.
230	250	Tuff, barren to weakly manganiferous.
250	266	Manganiferous tuff.
266	275	Barren tuff.

Diamond drill hole No. DH-11

Depth, feet From	To	Description
0	71	Basalt, no surface mantle.
71	88	White, friable sandstone, composed mostly of grains of volcanic glass.
88	95	Conglomerate of small pebbles of volcanic glass.
95	100	Arenaceous tuff.
100	110	Manganiferous arkosic sandstone.
110	135	Weakly manganiferous to manganese-stained arkosic sandstone.
135	140	Arenaceous tuff.
140	180	Erratically tuffaceous sandstone, coarse and porous in part.

Geologic log - diamond drill hole No. DH-12

Artillery Peak deposit

Logged by Benj. N. Webber M. A. Hanna Co.

Depth, feet From	To	Description
0	21	Vesicular basalt.
21	78	Dense basalt.
78	115	Vesicular, brown basalt.
115	127	Clean, white, friable sandstone with conglomerate beds.
127	134	Tuffaceous sandstone with limy partings.
134	135	Soft limestone.
135	137	Tuffaceous sandstone.
137	140	Manganese-stained, tuffaceous conglomerate.
140	146	Conglomerate of volcanic glass pebbles.
146	150	Sandy tuff with occasional pebbles of volcanic glass
150	154	Weakly manganiferous arkosic sandstone.
154	160	Devitrified opalite.
160	162	Friable, manganese-stained, silty sandstone.
162	182	Weakly manganiferous, arkosic sandstone, generally porous and somewhat friable.
182	207	Manganese-stained, friable, arkosic sandstone.
207	212	Barren, friable sandstone.
212	215	Manganese-stained sandstone.
215	218	Conglomerate sandstone.
218	221	Soft, friable, manganese-stained sandstone.

Geologic log - diamond drill hole No. DH-13

Artillery Peak deposit

Logged by Benj. N. Webber M. A. Hanna Co.

Depth, feet From	To	Description
0	14	Volcanic ash and sand.
14	130	Basalt, alternating dense and vesicular.
130	140	Arenaceous tuff.
140	142	Coarse-grained, calcareous sandstone.
142	150	Slightly arenaceous tuff.
150	152	Coarse-grained sandstone.
152	155	Finely laminated, light gray tuff.
155	160	Tuffaceous sandstone
160	178	Hard, siliceous, manganiferous arkose.
178	181	Devitrified opalite.
181	205	Arkosic sandstone, manganese-stained to weakly manganiferous.
205	206	Manganiferous sandstone.
206	211	Sandstone with traces of manganese.
211	216	Barren sandstone.

Diamond drill hole No. DH-21

Depth, feet From	To	Description
0	176	Basalt
176	182	Sandstone, ashy at top.
182	188	Conglomeratic grit.
188	222	Conglomerate, alluvial fan type.
222	236	Siltstone. Light colored, indurated silt.
236	244	Conglomeratic sandstone, light colored pumice fragments.
244	271	Arenaceous tuff, water sorted.
271	279	Barytic limestone.
279	290	Siltstone. Light colored, indurated silt.
290	293	Arkosic sandstone.
293	300	Arkosic sandstone, weakly manganiferous.
300	308	Arkosic sandstone, manganese-stained in part.
308	337	Manganiferous arkose.
337	344	Arkose, low-grade manganese.
344	354	Weakly manganiferous arkose.
354	367	Calcareous, arkosic sandstone, manganese stained.

Geologic log - diamond drill hole No. DH-22

Artillery Peak deposit

Logged by Benj. N. Webber M. A. Hanna Co.

Depth, feet From	To	Description
0	148	Basalt.
148	159	Conglomeratic, ashy sandstone, pebbles largely pumice or volcanic glass.
159	162	Barytic limestone, irregularly bedded, impure, limy material.
162	181	Arenaceous tuff, weakly manganiferous.
181	195	Manganiferous, arkosic sandstone.
195	196	Bentonite.
196	235	Soft, tuffaceous arkose and water-sorted, arenaceous tuff, intercalated manganiferous and barren beds.
235	265	Barren, tuffaceous arkose.

Diamond drill hole No. DH-23

Depth, feet From	To	Description
0	180	Basalt.
180	315	Soft, poorly cemented conglomerate. Pebbles of granite, gneiss, quartzite, latite, basalt, and volcanic glass.
315	320	Conglomeratic grit, grades into tuffaceous sandstone.
320	325	Conglomerate, small pebbles.
325	330	Conglomeratic sandstone.
330	342	Grit.
342	345	Ashy sandstone, many small fragments of volcanic glass.
345	350	Ashy sandstone, weakly manganiferous.
350	360	Ashy sandstone, glass fragments altering to bentonite.
360	365	Red, sandy clay.
365	375	Conglomerate.
375	388	Soft, friable sandstone.

Geologic log - diamond drill hole No. DH-24

Artillery Peak deposit

Logged by Benj. N. Webber M. A. Hanna Co.

Depth, feet From	To	Description
0	7	Caliche and basalt boulders.
7	140	Basalt.
140	142	Conglomerate.
142	152	Ashy sandstone.
152	155	Barytic limestone.
155	161	Conglomerate.
161	166	Conglomerate sandstone.
166	170	Arkosic sandstone, weakly manganiferous.
170	231	Very red, conglomeratic, friable material; in part sandy.
231	291	Predominantly friable, red sandstone with some partings of tuffaceous material. Veinlets of barite and calcite. (May be pre-manganese red beds.)

Diamond drill hole No. DH-25

Depth, feet From	To	Description
0	75	Basalt.
75	96	Conglomerate.
96	104	Hard, gray sandstone; occasional manganese stains.
104	210	Conglomerate, conglomeratic grit, and sandstone. At 129 feet the conglomerate facies change from gray to red.
210	235	Sandstone, weakly manganiferous.
235	265	Fine, friable sand or siltstone; barren.

Diamond drill hole No. DH-26

Depth, feet From	To	Description
0	81	Basalt.
81	124	Conglomerate.
124	129	Sandy grit.
129	137	Conglomerate grit.
137	145	Sandstone, weakly manganiferous.
145	150	Conglomeratic sandstone.
150	190	Mainly conglomerate; some conglomeratic sandstones.
190	195	Soft, friable sandstone.
195	200	Conglomeratic sandstone.
200	255	Sandy silts and clays.

Geologic log - diamond drill hole No. DH-27

Artillery Peak deposit

Logged by Benj. N. Webber M. A. Hanna Co.

Depth, feet From	To	Description
0	80	Basalt.
80	83	Ashy sandstone.
83	108	Conglomerate and conglomeratic sandstone.
108	113	Hard, gritty sandstone, cemented in part by opal.
113	143	Light, friable sandstone with a few pebbles.
143	161	Soft sandstone, weakly manganiferous.
161	163	Barren sandstone.
163	168	Sandstone, weakly manganiferous.
168	178	Manganiferous arkose.
178	190	Soft sandstone or arenaceous tuff, weakly and erratically manganiferous.
190	195	Conglomerate sandstone.
195	240	Soft, manganese-stained sandstone of volcanic glass sand.
240	275	Soft, manganese-stained sandstone of volcanic glass sand, with partings of opal-cemented sand.

Diamond drill hole No. DH-28

Depth, feet From	To	Description
0	112	Basalt.
112	160	Coarse-grained conglomeratic sandstone and conglomerate.
160	165	Hard, gray sandstone.
165	240	Sandy clay and argillaceous sand containing few pebbles.
240	244	Arkosic sandstone, weakly manganiferous.
244	260	Arkosic sandstone; in part manganese stained.
260	270	Sandstone mainly composed of grains of volcanic glass; in part manganese stained.
270	295	Sandstone as above, but finer grained and barren of manganese stain.

APPENDIX II

Assay log - diamond drill hole No. B-1

Artillery Peak Project 302

Location: On Maggie No. 7 claim, 640' N. and 80' W. of S.E. corner.
Altitude of collar: 2,433 feet — Depth: 576 feet
Started: 12/3/40 — Finished: 12/31/40

Footage			Weight, grams		Pct. recovery		Pct. manganese		
From	To	Feet	Core	Sludge	Core	Total sample	Core	Sldg.	Adj. Ave.
0	6	6			42				
6	11.5	5.5			67				
11.5	31.5	20			50				
31.5	57.5	26			78				
57.5	100	42.5			71				
100	116	16			72				
116	129	13			97				
129	144.5	15.5			62				
144.5	181	36.5			27				
181	188.8	7.8			0				
188.8	192.3	3.5		8,380	0	144		0.9	
192.3	198	5.7	1,818		40	90	2.9	2.6	
198	203	5	4,150	5,960	104	121	12.8	8.7	10.4
203	208	5	3,838	5,247	96	109	13.4		13.4
208	213	5	4,054	3,898	101	95	10.5	10.2	10.35
213	218	5	3,565	5,950	83	106	11.8	10.4	10.9
218	223	5	3,237	4,000	81	87	4.2	4.1	4.14
223	228	5	2,714	5,780	68	102	5.2	4.4	4.6
228	233	5	2,220	5,230	56	89	5.7	4.8	5.0
233	238	5	4,473	760	112	63	2.3	1.7	2.2
238	243	5	2,165		114		1.2		1.2
243	248	5	2,140	980	113	58	3.4	2.5	3.1
248	253	5	2,132	1,386	112	66	2.1	1.3	1.8
253	258	5	2,210		116		1.9		1.9
258	263	5	1,502		115				
263	268	5	1,491	1,644	78	58	3.0	1.6	2.3
268	273	5	1,400	3,811	73	98	2.0	1.7	1.8
273	278	5	1,835		96				
278	283	5	691		44				
283	288	5	1,221		62				
288	293	5		3,755	0			1.0	1.0
293	298	5	1,020	7,123	72		2.8	1.4	1.45
298	333	35			59		Not assayed		
333	576	243	(28 runs)		24		1/	0.45	

1/ Weighted sludge average. Material drilled varied from 0.3 to 0.8 percent manganese.

Assay log - diamond drill hole No. B-2

Artillery Peak Project 303

Location: On Maggie No. 9 claim, 330' S. and 115' E. of N.W. corner.
Altitude of collar: 2,412 feet — Depth: 248 feet
Started: 12/3/40 — Finished: 12/14/40

Footage			Weight, grams		Pct. recovery		Pct. manganese		
From	To	Feet	Core	Sludge	Core	Total sample	Core	Sldg.	Adj. ave.
0	12.3	12.3			31				
12.3	30	17.7			62				
30	88.5	58.5			95				
88.5	92.5	4			50				
92.5	103	10.5			76				
103	129	26			65				
129	160	31			16				
160	167	7			20				
167	168	1			0				
168	170	2	1,200		100	100	13.1		13.1
170	175	5	866		52	95	5.6	5.1	5.35
175	180	5	579		30	83	11.8	10.1	10.3
180	185	5	1,134	1,442	50	48	14.8	14.4	14.6
185	190	5	1,574	7,630	83	170	11.6	12.4	12.24
190	195	5	1,143		60		7.0	9.7	8.75
195	200	5	368	5,658	20	120	1.3	2.5	2.2
200	205	5	579	4,862	30	95	2.3	3.5	3.1
205	210	5	1,066	4,145	56	94	3.4	3.6	3.6
210	205	5	1,644	4,613	87	117	3.1	2.4	2.9
215	220	5	1,478	3,873	78	100	2.0	2.0	2.0
220	225	5	1,611	3,588	85	97	2.0	2.0	2.0
225	230	5	532	8,546	28	171	2.7	.8	1.0
230	235	5		4,617	0	86		1.4	1.4
235	240	5		4,425	0	83		6.3	6.3
240	245	5	647	2,244	34	54	1.0	.6	.7
245	248	3	1,155	1,995	61	59	2.0	1.1	1.3

A casing coupling was lost in the bottom of the hole just before intersecting the ore. The coupling could not be fished out. Coupling and core were cut at the same time, resulting in poor core recovery.

Assay log - diamond drill hole No. B-3

Artillery Peak Project 303

Location: On Maggie No. 16 claim, 210' S. and 55' E. of N.W. corner
Altitude of collar: 2,458 feet — Depth: 250 feet
Started: 1/9/41 — Finished: 1/21/41

Footage			Weight, grams		Pct. recovery		Pct. manganese		
From	To	Feet	Core	Sludge	Core	Total sample	Core	Sldg.	Adj. ave.
0	5	5			40				
5	32	27			100				
32	45	13			91				
45	70	25			100				
70	85	15			77				
85	95	10			76				
95	110	15			80				
110	125	15			76				
125	130	5	1/	1/	6		0.5	0.6	0.5
130	135	5	1/	1/	8		.3	.6	.5
135	140	5		1/	0			.4	.4
140	145	5	251	4,707	13	93		.8	.8
145	150	5	803	4,729	42	103	.4	.6	.5
150	155	5	330	4,361	17	88	.9	.8	.8
155	160	5	368	3,945	19	81	1.3	1.7	1.6
160	165	5	114	5,892	6	112	6.2	4.3	4.34
165	170	5	693	3,108	37	71	2.4	3.0	2.9
170	175	5	900	3,560	47	83	2.4	1.7	1.8
175	180	5	1,214	2,939	64	78	2.2	2.2	2.2
180	185	5	715	4,562	38	99	2.4	1.9	2.0
185	190	5	1,258	4,197	66	102	2.7	2.2	2.4
190	195	5	1,062	3,898	56	93	5.0	3.5	3.8
195	200	5	472	4,663	25	96	2.3	2.2	2.2
200	205	5		4,853	0	91		1.3	1.3
205	210	5	177	5,347	9	103	1.2	1.2	1.2
210	215	5		5,322	0	99		1.4	1.4
215	220	5	29	5,359	2	100		1.1	1.1
220	225	5	635	4,736	33	100	3.3	1.7	1.9
225	230	5	309	4,465	16	89	4.5	3.4	3.5
230	235	5	67	5,024	3	99		2.0	2.0
235	240	5		3,895	0	73		1.1	1.1
240	245	5	1,116	4,665	59	108	.3	.6	.5
245	250	5	978	2,815	51	71	.6	.9	.8

1/ Core and sludge not weighed in waste.

Assay log - diamond drill hole No. B-4

Artillery Peak Project 303

Location: On Maggie No. 9 claim, 725' S. and 40' W. of N.E. corner
Altitude of collar: 2,439 feet — Depth: 270 feet
Started: 12/17/40 — Finished: 1/7/41

Footage			Weight, grams		Pct. recovery		Pct. manganese		
From	To	Feet	Core	Sludge	Core	Total sample	Core	Sldg.	Adj. ave.
0	16	16			25				
16	40	24			57				
40	110	70			49				
110	121	11			55				
121	136	15			27				
136	151	15			0				
151	156.5	5.5			4				
156.5	160.3	3.8	1,293	4,115	32	65	6.9	5.0	5.45
160.3	165.3	5	527	10,612	13	124	3.8	6.5	6.36
165.3	166.5	1.2	689	1,441	17	24	3.2	3.4	3.4
166.5	171.5	5	1,217	5,009	30	70	8.3	4.5	5.24
171.5	176.5	5	614	5,509	32	114	2.0	2.2	2.2
176.5	181.5	5	448	4,814	24	100	1.3	1.3	1.3
181.5	185	3.5	533	2,682	28	60	2.2	2.0	2.0
185	190	5	964	3,398	51	82	2.1	1.9	2.0
190	195	5	1,652	4,240	87	110	2.6	2.0	2.2
195	200	5	1,429	4,216	75	105	3.3	3.1	3.2
200	205	5	82	5,548	4	105	2.8	1.2	1.3
205	210	5	482	6,205	25	125	.2	.6	.56
210	215	5	426	2,005	22	45	1.0	1.4	1.4
215	220	5	50	2,731	3	52		1.3	1.3
220	225	5	354	3,148	19	65	.8	1.7	1.6
225	230	5	510	7,391	27	148	.7	1.2	1.2
230	235	5	611	5,777	32	119	6.3	2.0	2.4
235	240	5	465	4,909	24	100	3.8	2.6	2.7
240	245	5	1,528	2,858	80	82	.9	1.0	1.0
245	250	5	589	4,847	31	102		1.4	1.4
250	255	5	1,579	5,594	83	134		1.8	1.8
255	260	5	1,620	5,335	85	130		1.4	1.4
260	265	5	2,002	3,834	100	109		.7	.7
265	270	5	1,954	3,089	100	94		.4	.4

Assay log - diamond drill hole No. B-5

Artillery Peak Project 303

Location: On Maggie No. 12 claim, 245' S. and 140' E. of N.W. corner.
Altitude of collar: 2,480 feet — Depth: 528 feet
Started: 1/11/41 — Finished: 2/3/41

Footage			Weight, grams		Pct. recovery		Pct. manganese		
From	To	Feet	Core	Sludge	Core	Total sample	Core	Sldg.	Adj. ave.
0	5	5			0				
5	29	24			0				
29	33.5	4.5			82				
33.5	44	10.5			59				
44	46	2			50				
46	55	9			33				
55	118	63			68				
118	136	18			3				
136	140	4			100		7.4		7.4
140	145	5		6,632	26	92	11.2	9.6	9.82
145	150	5		2,377	16	36	17.0	13.7	14.4
150	155	5		4,241	20	60	12.4	7.3	8.1
155	160	5		0	17	8	4.6		4.6
160	165	5		3,604	21	53	5.0	5.8	5.65
165	170	5		7,815	16	101	2.8	3.5	3.4
170	175	5		9,035	1	107	2.2	2.8	2.8
175	180	5		21,660	0	258		2.0	2.0
180	185	5		1,487	16	26	.9	1.5	1.3
185	200	15		0	0				
200	205	5		10,963	0	131		1.1	1.1
205	210	5		0	0				
210	215	5			12	22	.1	.4	.3
215	220	5		9,500	0	115		.9	.9
220	225	5			0	34		1.5	1.5
225	230	5		6,558	0	79		.8	.8
230	235	5		9,925	72	153	.3	.5	.4
235	240	5		5,610	90	105	.2	.6	.5
240	245	5			76	44	.4	.7	.5
245	250	5			40	25	.3	.6	.5
250	255	5			22	15	.3	.6	.5
255	260	5			62	27	.6	.6	.6
260	265	5			62	23	.3	.3	.3
265	270	5			52	31	.3	.5	.4
270	275	5			52	31	.4	.5	.5
275	280	5		1,937	14	29	.3	.5	.4
280	285	5			14	19		.8	.5
285	290	5			24	33	.6	.4	.5
290	295	5			24	24		.2	.2

Assay log - diamond drill hole No. B-5
Continued

Artillery Peak Project 303

Footage			Weight, grams		Pct. recovery		Pct. manganese		
From	To	Feet	Core	Sludge	Core	Total sample	Core	Sldg.	Adj. ave.
295	300	5			0	39		0.6	0.6
300	305	5			0	21		.7	.7
305	310	5			90	116	1.5	.8	1.0
310	315	5		5,444	98	99	1.6	.9	1.1
315	320	5			56	46	3.6	.6	1.6
320	325	5			78	52	1.3	1.0	1.1
325	330	5			0			.7	.7
330	335	5		1,542	0	19		1.3	1.3
335	340	5		4,409	0	53		1.1	1.1
340	345	5			0			.9	.9
345	350	5			0	63		1.0	1.0
350	355	5		3,174	0	38		1.0	1.0
355	360	5		2,318	0	28		1.0	1.0
360	365	5		4,042	0	49		.9	.9
365	370	5			0				
370	375	5			0				
375	380	5			0	33		.6	.6
380	385	5			0	32		.7	.7
385	390	5		3,335	0	40		.6	.6
390	395	5		2,782	0	33		.5	.5
395	400	5			0	48		1.1	1.1
400	405	5		6,150	0	73		.5	.5
405	410	5		2,832	0	32		1.2	1.2
410	415	5			0	34		.9	.9
415	420	5		3,466	44	51	1.5	.9	1.1
420	425	5		5,790	100	93	2.9	.9	2.9
425	430	5		2,089	0	25		1.0	1.0
430	435	5		2,920	0	35		1.1	1.1
435	440	5		3,685	82	64	1.3	1.1	1.15
440	445	5		5,175	80	86	1.0	1.0	1.0
445	450	5		4,700	56	71	.4	1.2	1.0
450	455	5		3,235	6	39		1.1	1.1
455	465	10		3,700	38	54	.5	1.2	1.1
465	475	10		3,468	0	41		.9	.9
475	485	10		1,588	0	19		.8	.8
485	495	10		1,536	0	18		.9	.9
495	505	10		1,849	0	22		.8	.8
505	515	10		2,989	98	64	.5	.8	.7
515	525	10		2,414	0	29		.7	.7
525	528	3			26	90	.4	.8	.6

Assay log - diamond drill hole No. B-6

Artillery Peak Project 303

Location: On Maggie No. 12 claim, 760' S. and 30' E. of N.W. corner.
Altitude of collar: 2,477 feet. Depth: 250 feet
Started: 1/22/41 Finished: 2/1/41

Footage			Weight, grams		Pct. recovery		Pct. manganese		
From	To	Feet	Core	Sludge	Core	Total sample	Core	Sldg.	Adj. ave.
0	23	23			80				
23	80	57			95				
80	92	12			95				
92	122	30			75				
122	128	6			35				
128	130	2			25				
130	135	5	65	3,398	5	65		1.0	1.0
135	136	1	440	2,805	30	60	1.4	1.8	1.7
136	140	4			35		6.5		6.5
140	145	5	382	3,425	20	71	3.7	2.3	2.4
145	150	5	26	3,780	1	71	1.3	1.5	1.5
150	155	5	93	4,490	5	86	1.4	1.5	1.5
155	160	5	277	5,573	15	108	2.1	1.0	1.1
160	165	5	40	4,470	2	84	12.9	4.4	4.48
165	170	5	20	4,180	1	78	16.5	3.7	3.76
170	175	5	46	6,587	3	124	1.6	1.3	1.3
175	180	5	243	6,770	13	131	.5	1.3	1.2
180	185	5	870	5,179	46	113	1.1	1.5	1.4
185	190	5	362	4,930	19	99	1.0	1.3	1.3
190	195	5	409 403	4,423	43	98	3.7 1.0	2.5	2.5
195	200	5	1,017	4,110	53	96	2.7	2.1	2.2
200	205	5	800 670	3,350	77	90	1.3 1.0	1.2	1.2
205	210	5	309 1,110	2,910	75	81	.2 2.8	1.8	1.3
210	215	5	1,367	3,173	72	85	.5	.9	.8
215	220	5	1,366	2,115	72	65	.5	.9	.7
220	225	5	1,166	3,415	61	86	.3	1.0	.8
225	230	5	940	3,586	50	84	.6	.8	.76
230	235	5	1,226	1,424	65	50	.4	.7	.56
235	240	5	125 1,407	650	80	41	2.1 1.2	.9	1.16
240	245	5	799		42		.7	.7	.7
245	250	5	479	2,265	25	51	.2	.6	.53

Assay log - diamond drill hole No. B-7

Artillery Peak Project 303

Location: 775' S. and 300' E. from N.W. corner of section 32.
Altitude of collar: 2,488 feet Depth: 250 feet
Started: 2/1/41 Finished: 2/10/41

Footage			Weight, grams		Pct. recovery		Pct. manganese		
From	To	Feet	Core	Sludge	Core	Total sample	Core	Sldg.	Adj. ave.
0	2	2			100				
2	48	46			76				
48	60	12			100				
60	89	29			93				
89	111	22			95				
111	115	4		2,995	15	87		1.7	1.7
115	120	5	1,243	4,411	65	106	20.7	16.5	17.4
120	125	5	602	4,548	32	96	13.8	8.3	8.93
125	130	5	233	4,296	12	84	16.1	5.8	6.33
130	135	5	1,039	3,136	55	78	2.9	3.3	3.2
135	140	5	500	2,149	26	49	2.7	3.1	3.0
140	145	5	595	4,157	31	89	2.6	3.6	3.4
145	150	5	452	3,813	24	78	3.0	3.0	3.0
150	155	5	402	4,868	21	99	3.0	2.8	2.8
155	160	5		3,705	0	69		2.9	2.9
160	165	5	46	4,825	2	91		.8	.8
165	170	5		5,593	0	104		1.3	1.3
170	175	5	86	4,679	5	89		1.3	1.3
175	180	5		4,361	0	81		1.0	1.0
180	185	5	25	5,587	1	105		4.1	4.1
185	190	5	299	4,351	16	87	4.8	3.5	3.6
190	195	5	99	3,873	5	74		1.9	1.9
195	200	5	650	4,892	34	105	2.7	1.8	1.9
200	205	5	914	3,449	48	81	3.3	2.9	3.0
205	210	5	1,136	4,037	60	97	1.3	1.3	1.3
210	215	5	1,216	3,085	64	80	1.5	1.5	1.5
215	220	5	1,611	2,510	85	77	1.3	.8	1.1
220	225	5	830	2,575	44	64		.9	.9
225	230	5	907	2,552	47	65		.9	.9
230	240	10	2,764	4,257	73	65		.8	.8
240	250	10	1,274	5,319	34	123		.7	.7

Assay log - diamond drill hole No. B-8

Artillery Peak Project 303

Location: 390' S., 670' E. from N. W. corner of section 32.
Altitude of collar: 2,514 feet — Depth: 250 feet
Started: 2/5/41 — Finished: 2/11/41

Footage			Weight, grams		Pct. recovery		Pct. manganese		
From	To	Feet	Core	Sludge	Core	Total sample	Core	Sldg.	Adj. ave.
0	10	10			80				
10	91	81			45				
91	95	4	298		75				
95	100	5	2,398	3,570	60	71		0.6	
100	105	5	1,070	7,176	27	99	2.4	.8	
105	110	5	602	6,469	32	131	1.1	.4	
110	115	5	837	3,243	44	76	4.7	4.5	4.53
115	120	5	355	5,631	19	112	4.2	4.3	4.29
120	125	5	454	4,656	24	96	5.8	3.9	4.07
125	130	5	560	5,730	29	117	1.2	1.4	1.4
130	135	5	414	4,954	22	100	2.0	1.6	1.6
135	140	5	863	4,068	46	92	2.3	2.6	2.5
140	145	5	1,049	3,340	55	82	3.0	3.0	3.0
145	150	5	141	4,676	7	90	3.8	3.6	3.6
150	155	5	402	4,122	21	85	1.8	2.4	2.4
155	160	5	731	5,115	38	109	1.6	1.9	1.9
160	165	5	851	4,095	45	91	2.0	2.2	2.2
165	170	5	1,120	1,845	59	55	2.7	2.3	2.4
170	175	5	628	5,180	33	109	1.2	1.9	1.82
175	180	5	1,115		59	21	1.4	1.9	1.7
180	185	5	99	3,998	5	76	3.0	2.3	2.3
185	190	5	156		8	3	4.0	2.3	3.5
190	195	5	180	4,867	10	94	3.5	1.3	1.37
195	200	5	849	1,766	45	49	1.0	.9	.93
200	205	5	1,257	2,334	66	67	.7	.7	.7
205	215	10	3,016	1,129	79	50	.7	.6	.7
215	225	10	2,380	1,397	63	45	.4	.8	.6
225	235	10	2,063	2,679	54	57	.9	.5	.7
235	245	10	1,863	2,182	49	50	.7	.6	.7
245	250	5	766 449	3,307	64	85	3.0 .7	.7	1.09

Assay log - diamond drill hole No. B-11

Artillery Peak Project 303

Location: On Maggie No. 22 claim, 520' S. and 160' E. of N.W. corner.
Altitude of collar: 2,584 feet — Depth: 180 feet
Started: 3/27/41 — Finished: 4/1/41

Footage			Weight, grams		Pct. recovery		Pct. manganese		
From	To	Feet	Core	Sludge	Core	Total sample	Core	Sludge	Adj. ave.
0	13	13			85				
13	26	13			86				
26	53	27			86				
53	60	7			80				
60	84	24			83				
84	100	16			56				
100	126	26			55				
126	134	8	490	7,826	26	155		0.6	0.6
134	140	6	840	5,820	44	124	1.05	2.6	2.4
140	145	5	734	4,490	39	98	2.7	4.4	4.15
145	150	5	663	4,024	35	87	2.8	2.2	2.3
150	155	5	1,170	3,438	62	86	1.3	3.1	2.7
155	160	5	38	4,441	2	84		1.5	1.5
160	165	5	114	5,830	6	111	1.2	1.4	1.4
165	170	5	40	4,419	2	83		1.9	1.9
170	175	5	197	4,565	10	89	1.5	1.4	1.4
175	180	5		6,058	0	113		1.1	1.1

Assay log - diamond drill hole No. B-12

Artillery Peak Project 303

Location: On Maggie No. 15 claim, 665' S. and 225' E. of N.W. corner.
Altitude of collar: 2,534 feet — Depth: 261 feet
Started: 2/13/41 — Finished: 2/22/41

Footage			Weight, grams		Pct. recovery		Pct. manganese		
From	To	Feet	Core	Sludge	Core	Total sample	Core	Sldg.	Adj. ave.
0	18	18			78				
18	80	62			81				
80	86	6			67				
86	91	5			20				
91	106	15			87				
106	126	20			33				
126	131	5	319	6,810	17	134	9.6	5.4	5.6
131	136	5	1,412	3,693	74	95	7.3	5.4	5.7
136	141	5	803	6,136	42	130	2.6	3.8	3.61
141	146	5	1,419	3,276	74	87	2.7	2.5	2.6
146	151	5	931	3,134	49	77	4.5	3.2	3.5
151	156	5	695	4,120	37	90	3.7	3.2	3.27
156	161	5		7,340	0	137		3.1	3.1
161	166	5		5,863	2	110		2.2	2.2
166	171	5		4,381	0	82		2.3	2.3
171	176	5	564	5,598	30	115	1.5	3.4	3.2
176	181	5	942	5,207	50	115	2.5	2.9	2.85
181	186	5	737	3,825	39	85	2.2	2.3	2.3
186	191	5	558	3,126	29	70	2.8	2.6	2.6
191	196	5		5,592	0	104		2.8	2.8
196	201	5	126	4,019	7	78	2.8	3.6	3.6
201	206	5		4,729	0	89		3.0	3.0
206	211	5	275	4,432	14	88	5.1	2.9	3.02
211	216	5		3,466	14	65		1.5	1.5
216	221	5		4,506	0	84		1.4	1.4
221	226	5	83	3,798	4	74	3.0	2.0	2.0
226	231	5	559	5,906	29	121	.8	.6	.6
231	236	5	305	4,512	16	90	1.0	1.1	1.1
236	241	5	713	3,695	37	82	.3	1.3	1.14
241	246	5	862	1,611	45	46	.7	1.0	1.1
246	251	5	656	1,618	35	42	.6	.7	.7
251	256	5	1,080	3,063	57	79	.3	.8	.6
256	261	5	1,160	3,074	61	79	.7	1.5	1.28

Assay log - diamond drill hole No. B-13

Artillery Peak Project 303

Location: On Maggie No. 14 claim, 400' N. and 260' W. of S.E. corner
Altitude of collar: 2,504 feet — Depth: 183 feet
Started: 3/10/41 — Finished: 3/17/41

Footage			Weight, grams		Pct. recovery		Pct. manganese		
From	To	Feet	Core	Sludge	Core	Total sample	Core	Sldg.	Adj. ave.
0	18	18			72				
18	70	52			56				
70	81	11			45				
81	88	7			29				
88	92.5	4.5		2,143	0	40		0.7	0.7
92.5	98	6.5	353	5,354	18	107	12.4	6.8	7.14
98	103	5	1,005	3,186	53	79	5.5	5.5	5.5
103	108	5	1,630	1,520	86	59	6.6	7.3	6.9
108	113	5	816	4,084	43	91	4.6	4.7	4.68
113	118	5		4,915	6	92	7.1	3.8	3.9
118	123	5		4,608	8	86	9.2	6.2	6.4
123	128	5	350	4,415	18	89	8.2	5.8	5.96
128	133	5	620	4,830	33	102	4.3	5.8	5.63
133	138	5	329	3,739	17	77	2.8	3.5	3.44
138	143	5		6,247	0	117		3.0	3.0
143	148	5	206	6,249	10	121		2.2	2.2
148	153	5	435	4,518	23	93	2.8	2.8	2.8
153	158	5	159	5,448	8	105	3.3	3.2	3.2
158	163	5	601	4,528	31	96	2.6	3.0	2.95
163	168	5		5,923	0	111		2.7	2.7
168	173	5	159	4,123	8	80	3.5	1.5	1.57
173	178	5		5,095	0	95		2.0	2.0
178	183	5		8,840	0	166		1.2	1.2

Assay log - diamond drill hole No. B-14

Artillery Peak Project 303

Location: On Maggie No. 9 claim, 190' N. and 160' E. of S.W. corner
Altitude of collar: 2,416 feet — Depth: 250 feet
Started: 3/18/41 — Finished: 3/26/41

Footage			Weight, grams		Pct. recovery		Pct. manganese		
From	To	Feet	Core	Sludge	Core	Total sample	Core	Sldg.	Adj. ave.
0	10	10			60				
10	26	16			87				
26	70	44			75				
70	126	56			89				
126	156	30			66				
156	166	10	685	10,935	17	140	0.6	0.5	0.5
166	176	10		15,440	0	185		.3	.3
176	183	7	724	13,370	18	170	1.0	.5	.8
183	186	7	1,113	17,565	80	287	2.7		3.25
186	190		2,078				3.6		
190	195	5	1,145	1,331	60	46	2.1	1.5	1.78
195	200	5	1,211	5,168	64	119	1.9	1.5	1.57
200	205	5	1,767	2,825	93	86	3.0	2.1	2.5
205	210	5	2,231	4,436	117	124	2.3	3.6	3.09
210	215	5	1,941	2,374	102	81	4.9	3.0	3.85
215	220	5	1,582	2,046	83	68	3.9	2.1	2.88
220	225	5	2,012	3,010	106	94	1.9	2.0	2.0
225	230	5	2,129	2,497	112	87	1.1	1.5	1.3
230	235	5	363	2,969	19	62	1.7	1.7	1.7
235	240	5	298	4,782	16	95	2.5	2.9	2.8
240	245	5	1,848	3,776	97	105	1.3	1.4	1.4
245	250	5	2,058	2,640	108	88	2.8	1.8	2.4

Assay log - diamond drill hole No. B-15

Artillery Peak Project 303

Location: On Maggie No. 16 claim, 110' N. and 290' E. of S.W. corner.
Altitude of collar: 2,451 feet — Depth: 270 feet
Started: 2/24/41 — Finished: 3/8/41

Footage			Weight, grams		Pct. recovery		Pct. manganese		
From	To	Feet	Core	Sludge	Core	Total sample	Core	Sldg.	Adj. ave.
0	4	4			62				
4	21	17			32				
21	51	30			45				
51	64	13			69				
64	89	25			50				
89	106	17			76				
106	133	27			63				
133	145	12			58				
145	150	5		4,053	0	75		0.3	0.3
150	155	5		4,101	0	77		.3	.3
155	165	10	1,446	7,925	76	176		.4	.4
165	170	5	1,252	2,865	66	78		.4	.4
170	175	5	1,264	3,228	67	82		.4	.4
175	180	5	162	4,770	9	92		.4	.4
180	185	5	178	3,285	9	65		.4	.4
185	189	4	993	5,699	52	125		.5	.5
189	190	1		1,157		22		1.8	1.8
190	192	5	1/ 200	4,553	20	90	9.7	2/ 5.2	9.7
192	195		245						
195	200	5	350	190	18	10	17.5	5.4	13.2
200	205	5	574	4,315	30	91	22.3	12.8	13.9
205	210	5	975	4,230	51	98	9.4	8.0	8.2
210	215	5	682	4,739	36	101	8.2	6.0	6.26
215	220	5	1,025	2,910	54	74		4.1	4.1
220	225	5	350	3,865	18	80	.6	3.1	2.9
225	230	5	1,160	4,601	61	108	3.2	2.5	2.64
230	235	5	1,315	3,556	69	91	1.8	1.7	1.72
235	240	5	943	3,015	50	75	1.5	1.6	1.57
240	245	5	1,314	3,339	69	87	2.1	1.7	1.8
245	250	5	1,542	3,268	81	90	2.3	2.0	2.1
250	255	5	1,656	3,267	87	92	1.6	1.6	1.6
255	260	5	948	2,823	50	70	1.4	1.3	1.3
260	265	5	920	4,919	48	109	1.2	1.3	1.3
265	270	5	837	3,192	44	75	.4	.7	.64

1/ Waste, not assayed.
2/ Sludge sample includes 2 feet of waste; assay not used.

Assay log - diamond drill hole No. B-17

Artillery Peak Project 303

Location: On Maggie No. 13 claim, 860' N. and 250' W. of S.E. corner.
Altitude of collar: 2,490 feet — Depth: 240 feet
Started: 2/11/41 — Finished: 2/22/41

Footage			Weight, grams		Pct. recovery		Pct. manganese		
From	To	Feet	Core	Sludge	Core	Total sample	Core	Sldg.	Adj. ave.
0	103	103			74				
103	105	2		2,028	0	38		0.6	0.6
105	110	5	264		14	5	1.0		1.0
110	115	5	521		27	9	.2		.2
115	116.5	1.5			0	0			
116.5	120	3.5	1,704	6,312	2	118		1.0	1.0
120	125	5	140	4,612	8	89	1.2	2.9	2.8
125	130	5		4,673	0	87		9.4	9.4
130	135	5		4,153	0	78		7.5	7.5
135	140	5		4,398	0	82		4.8	4.8
140	145	5	120	3,960	6	76		6.2	6.2
145	150	5		3,081	0	58		8.4	8.4
150	155	5		3,862	0	72		6.2	6.2
155	160	5		3,525	0	66		7.5	7.5
160	165	5		3,644	0	68		5.5	5.5
165	170	5		1,404	0	26		4.2	4.2
170	175	5			0	0			
175	180	5	454		24	8	4.2		4.2
180	185	5	287	4,597	15	91	4.3	3.4	3.4
185	190	5	93	5,468	5	104	3.6	2.6	2.6
190	195	5		4,734	0	88		2.1	2.1
195	200	5	458	3,932	24	82	2.4	1.4	1.5
200	205	5		4,833	0	90		1.5	1.5
205	210	5		4,340	2	81		1.5	1.5
210	215	5		5,201	2	97		1.3	1.3
215	220	5	160	4,033	9	77	2.0	1.6	1.6
220	225	5	180	5,333	10	103	1.0	.8	.8
225	230	5	364	3,374	19	70	.3	.5	.5
230	235	5	152	2,872	8	57		.7	.7
235	240	5	196	3,087	10	61	.4	.5	.5

Assay log - diamond drill hole No. B-18

Artillery Peak Project 303

Location: On Maggie No. 7-A claim, 500' S. and 125' E. of N.W. corner.
Altitude of collar: 2,441 feet — Depth: 310 feet
Started: 2/24/41 — Finished: 3/12/41

Footage			Weight, grams		Pct. recovery		Pct. manganese		
From	To	Feet	Core	Sludge	Core	Total sample	Core	Sldg.	Adj. ave.
0	30	30			86				
30	100	70			83				
100	128	28			85				
128	144	16			88				
144	153	9			100				
153	157	4		3,408	10	65		2.2	2.2
157	162	5		6,062	2	113	5.8	7.9	7.9
162	167	5		5,423	0	101		5.2	5.2
167	172	5	25	6,705	2	126	1.7	3.6	3.58
172	177	5		6,957	4	130	.7	2.0	2.0
177	182	5		6,256	0	117		2.9	2.9
182	187	5	470	6,218	5	125	1.5	2.0	1.97
187	192	5	75	6,175	4	117	2.1	2.0	2.0
192	197	5	231	5,988	12	116	1.6	2.1	2.08
197	202	5		6,392	4	119	1.9	2.9	2.9
202	207	5		4,824	4	90	3.4	3.5	3.5
207	215	8		5,605	0	105		3.3	3.3
215	220	5	609	5,470	32	114	2.6	2.9	2.87
220	225	5	690	4,596	36	99	1.7	3.0	2.84
225	230	5	431	5,075	23	103	2.0	3.1	3.01
230	235	5	322	4,170	17	84		1.5	1.5
235	240	5	621	3,887	33	84	1.2	1.7	1.63
240	245	5	515	4,524	27	94		1.0	1.0
245	250	5	575	3,418	30	76		.9	.9
250	255	5	121	2,841	7	56	.2	.2	.2
255	260	5	259	1,177	10	27	.1	.1	.1
260	265	5	511	2,159	27	50	1.3	.9	.98
265	270	5	628	2,256	33	54	1.3	1.2	1.2
270	275	5	600	1,478	32	40		.3	.3
275	280	5	520	2,167	27	50		.3	.3
280	285	5	130	2,485	7	49		.4	.4
285	290	5			6			1/1.4	1.4
290	295	5	333		18	6		1.6	1.6
295	300	5			4			1.2	1.2
300	305	5			4			.6	.6
305	310	5			0			1.3	1.3

1/ Low grade material, split of sample retained for assay.

Assay log - diamond drill hole No. DH-3

M. A. Hanna Co.

Artillery Peak deposit

Location: On Maggie No. 12 claim, 517' S. and 20' W. of N.W. corner, section 32.
Altitude of collar: 2,493 feet — Depth: 406 feet
Started: 10/8/36 — Finished: 11/4/36

Footage			Percent core	Percent manganese		
From	To	Feet	recovery	Core	Sludge	Combined 1/
121	126	5	88	14.20	10.16	11.92
126	131	5	72	9.84	9.58	9.68
131	136	5	52	7.55	8.10	7.93
136	141	5	47	16.90	8.90	10.88
141	146	5	75	11.57	12.41	12.09
146	151	5	65	2.34	2.50	2.44
155	158	3	30	3.47	-	3.47
202	206	4	45	4.88	-	4.88

1/ Core and sludge analyses combined by volume calculation, based on percentage of core recovery. (This method is used in all Hanna Co. logs.)

Assay log - diamond drill hole No. DH-4

M. A. Hanna Co.

Artillery Peak deposit

Location: 1,350' S. and 1,820' E. of N.W. corner, Section 32.
Altitude of collar: 2,547 feet — Depth: 375 feet
Started: 11/4/36 — Finished: 11/28/36

Footage			Percent core	Percent manganese		
From	To	Feet	recovery	Core	Sludge	Combined
115	120	5	40	1.97	2.92	2.69
120	125	5	0		2.47	2.47
125	130	5	0		2.89	2.89
130	135	5	17	3.87	2.58	2.69
135	140	5	29	2.33	1.83	1.90
140	145	5	32	2.40	1.94	2.21
145	150	5	27	.74	8.04	1.86
165	170	5	45	2.10	-	2.10
170	175	5	33	1.64	-	1.64
177	180	3	0		2.52	2.52
229	234	5	58	2.65	-	2.65
242	245	3	42	2.02	-	2.02
249	253	4	77	2.04	-	2.04
260	265	5	88	6.85	-	6.85
265	270	5	13	1.62	1.92	1.91
270	275	5	88	2.36	3.88	3.03
275	280	5	43	3.60	2.92	3.06
280	285	5	32	3.60	2.30	2.57
310	315	5	58	4.0	-	4.0
320	325	5	58	4.0	-	4.0
327	330	3	57	2.9	-	2.9
330	335	5	0	-	1.16	1.16

Assay log - diamond drill hole No. DH-6

M. A. Hanna Co.

Artillery Peak deposit

Location: 1,240' S. and 1,780' W. of N.W. corner, section 32.
Altitude of collar: 2,423 feet — Depth: 288 feet
Started: 12/29/36 — Finished: 1/20/37

Footage			Percent core	Percent manganese		
From	To	Feet	recovery	Core	Sludge	Combined
235	237	2	83	3.70	-	3.70
237	238	Barren				
238	242	4	40	2.21	1.82	1.90
242	247	5	87	1.04	1.06	1.06
247	252	5	86	1.79	.99	1.34
252	260	Barren				
260	265	5	37	3.74	-	3.74
265	270	5	20	2.91	4.08	3.98

Assay log - diamond drill hole No. DH-7

M. A. Hanna Co.

Artillery Peak deposit

Location: 980' S. and 1,060' W. of N.W. corner, section 32.
Altitude of collar: 2,436 feet — Depth: 233 feet
Started: 1/21/37 — Finished: 2/7/37

Footage			Percent core	Percent manganese		
From	To	Feet	recovery	Core	Sludge	Combined
176	178	2	50	23.32	-	23.32
178	183	5	12	3.8	4.63	4.57
183	188	5	60	22.23	21.14	21.38
188	193	5	82	24.07	21.89	22.80
193	198	5	40	22.92	14.54	16.18
198	203	5	20	7.72	9.78	9.57
203	208	5	25	1.69	7.72	6.9
208	212	4	70	8.08	-	8.08

Diamond drill hole No. DH-8

Location: 1,780' S. and 740' W. of N.W. corner, section 32
Altitude of collar: 2,466 feet — Depth: 257 feet
Started: 2/9/37 — Finished: 2/21/37

Footage			Percent core	Percent manganese		
From	To	Feet	recovery	Core	Sludge	Combined
196	201	5	8	4.78	2.2	2.31
201	207	Barren				
207	212	5	23	3.99	2.8	2.93
212	217	5	60	4.24	5.04	4.83
217	222	5	30	1.46	2.7	2.60
222	227	5	17	8.85	5.69	5.91
227	232	5	17	1.20	3.60	3.43

Assay log - diamond drill hole No. DH-9

M. A. Hanna Co.

Artillery Peak deposit

Location: 1,045' S. and 660' E. of N.W. corner, section 32.
Altitude: 2,466 feet — Depth: 325 feet
Started: 2/22/37 — Finished: 3/13/37

Footage			Percent core	Percent manganese		
From	To	Feet	Recovery	Core	Sludge	Combined
101	105	4	63	1.25	-	1.25
105	110	5	10	3.94	-	3.94
110	114	4	7	7.98	3.18	3.34
114	115	1		8.67	3.68	4.67
115	120	5	25	1.0	.9	.91
120	125	5	10	2.05	1.46	1.49
125	130	5	50	1.55	1.20	1.29
130	135	5	20	2.47	1.53	1.52
135	140	5	20	1.74	.95	1.02
140	145	5	28	1.82	2.82	2.70
145	150	5	3	1.18	.64	.66
150	155	5	0		.71	.71
155	160	5	37	2.8	1.51	1.70
160	165	5	0		.59	.59
165	170	5	0		.46	.46
170	175	5	0		.51	.51
175	180	5	0		1.39	1.39
180	185	5	28		1.80	1.80
185	190	5	0		2.25	2.25
190	195	5	15	1.56	2.10	2.06
232	235	3	57	5.32	-	5.32
235	240	5	30	3.28	-	3.28
240	244	4	34	1.56	1.97	1.9
244	250	6	17	5.08	-	5.08
260	265	5	0		2.12	2.12

Assay log - diamond drill hole DH-10

M. A. Hanna Co.

Artillery Peak deposit

Location: 295' S. and 1,420' E. of N. W. corner, section 32
Altitude of collar: 2,565 feet — Depth: 275 feet
Started: 3/13/37 — Finished: 3/26/37

Footage			Percent core	Percent manganese		
From	To	Feet	recovery	Core	Sludge	Combined
89	92	3	8	2.25	3.87	3.69
92	97	5	33	1.04	-	1.04
101	102	1	33	5.97	-	5.97
102	107	5	45	2.80	-	2.80
107	112	5	32	3.65	-	3.65
115	120	5	0		3.0	3.0
120	125	5	0		2.6	2.6
125	130	5	0		2.0	2.0
208	210	2	73	2.70	-	2.70
210	215	5	78	2.50	-	2.50
224	225	1	73	3.50	-	3.50
250	255	5	23	3.87	-	3.87
255	260	5	18	1.18	3.25	3.01
260	262	2	0		3.65	3.65
262	265	3	0		2.85	2.85
265	266	1	0		5.85	5.85

Assay log - diamond drill hole DH-11

M. A. Hanna Co.

Artillery Peak deposit

Location: 520' N. and 530' E. of N.W. corner, section 32.
Altitude of collar: 2,564 feet — Depth: 180 feet
Started: 3/27/37 — Finished: 4/9/37

Footage			Percent core	Percent manganese		
From	To	Feet	recovery	Core	Sludge	Combined
100	105	5	70	13.0	8.60	10.13
105	110	5	38	6.57	7.52	7.35
110	115	5	56	5.17	4.55	4.71
125	130	5	86	2.92	3.17	3.05
130	135	5	0		2.80	2.80
135	140	5	74	2.66	3.00	2.88

Diamond drill hole No. DH-12

Location: 30' N. and 860' W. of N.W. corner, section 32.
Altitude of collar: 2,460 feet — Depth: 221 feet
Started: 4/9/37 — Finished: 4/27/37

Footage			Percent core	Percent manganese		
From	To	Feet	recovery	Core	Sludge	Combined
150	155	5	70	3.48	-	3.48
155	160	5	29	2.30	-	2.30
160	162	2	10	6.02	4.11	4.19
162	167	5	25	3.03	6.27	5.9
167	172	5	28	5.66	4.44	4.6
172	177	5	0		2.98	2.98
177	182	5	0		1.32	1.32

Assay log - diamond drill hole DH-13

M. A. Hanna Co.

Artillery Peak deposit

Location: 450' S. and 1,380' W. of N.W. corner, section 32.
Altitude of collar: 2,435 feet — Depth: 216 feet
Started: 4/27/37 — Finished: 5/6/37

Footage			Percent core	Percent manganese		
From	To	Feet	recovery	Core	Sludge	Combined
160	165	5	60	14.5	8.38	10.2
165	170	5	87	8.92	8.04	8.4
170	175	5	43	10.4	8.48	8.78
175	178	3	47	3.19	1.9	2.98
181	185	4	37	1.5		1.5
185	190	5	63	2.42		2.42
190	200	10	51	5.22		5.22
200	205	5	25	12.5		12.5
205	206	1	0		2.78	2.78

Diamond drill hole No. DH-21

Location: On Maggie No. 6 claim
Altitude of collar: 2,419 feet — Depth: 367 feet
Started: 5/26/39 — Finished: 6/15/39

Footage			Percent core	Percent manganese		
From	To	Feet	recovery	Core	Sludge	Combined
293	295	2	0		2.49	2.49
295	300	5	40	1.93	1.96	1.9
308	310	2	0		6.5	6.5
310	314	4	23	16.7	16.0	16.0
314	319	5	17	24.4	20.6	20.9
319	324	5	0		12.9	12.9
324	329	5	0		7.3	7.3
329	334	5	0		8.98	8.9
334	337	3	0		10.37	10.4
337	339	2	0		4.98	5.0
339	344	5	0		4.10	4.1
349	354	5	10	5.92	6.38	6.2

Assay log - diamond drill hole DH-22

M. A. Hanna Co.

Artillery Peak deposit

Location: On Maggie No. 7-A claim.
Altitude of collar: 2,497 feet — Depth: 265 feet
Started: 2/6/40 — Finished: 2/24/40

Footage			Percent core	Percent manganese		
From	To	Feet	recovery	Core	Sludge	Combined
159	162	3	50	9.08	5.82	6.60
164	169	5	22	2.80	4.57	4.36
181	186	5	4	23.05	12.00	12.21
186	191	5	0		14.76	14.76
191	195	4	30	27.56	13.33	15.33
200	202	2	0		3.23	3.23
205	210	5	0		6.42	6.42
210	215	5	10	9.54	4.53	4.73
215	220	5	0		2.82	2.82
220	225	5	0		2.73	2.73
228	230	2	0		3.25	3.25
230	235	5	0		2.29	2.29

Diamond drill hole No. DH-23

Location: On Muroc claim.
Altitude of collar: 2,510 feet — Depth: 388 feet

No assay log available.

Diamond drill hole No. DH-24

Location: On boundary between Monroc No. 1 and No. 2.
Altitude of collar: 2,593 feet. — Depth: 291 feet
Started: 3/10/40 — Finished: 3/21/40

Footage			Percent core	Percent manganese		
From	To	Feet	recovery	Core	Sludge	Combined
166	170	4	0		7.94	7.94

Assay log - diamond drill hole No. DH-25

M. A. Hanna Co.

Artillery Peak deposit

Location: 175' N. and 160' W. of S.E. corner of Muroc No. 3.
Altitude of collar: 2,581 feet — Depth: 265 feet
Started: 3/22/40 — Finished: 3/31/40

Footage			Percent core	Percent manganese		
From	To	Feet	recovery	Core	Sludge	Combined
210	215	5	0		1.91	1.91
215	220	5	0		3.21	3.21
220	225	5	0		2.66	2.66
225	230	5	0		3.13	3.13
230	235	5	0		1.84	1.84

Diamond drill hole No. DH-26

Location: 60' due north of S.E. corner Minnesota No. 7
Altitude of collar: 2,734 feet — Depth: 255 feet
Started: 4/1/40 — Finished: 4/9/40

Footage			Percent core	Percent manganese		
From	To	Feet	recovery	Core	Sludge	Combined
137	140	3	0		4.05	4.05
140	145	5	0		2.96	2.96

Assay log - diamond drill hole DH-27

M. A. Hanna Co.

Artillery Peak deposit

Location: 240' S. and 300' E. of N. W. corner Maggie No. 14
Altitude of collar: 2,551 feet — Depth: 275 feet
Started: 4/10/40 — Finished: 4/19/40

Footage			Percent core	Percent manganese		
From	To	Feet	recovery	Core	Sludge	Combined
143	148	5	0		7.96	7.96
148	153	5	0		7.97	7.97
153	155	2	0		6.22	6.22
159	161	2	0		8.29	8.29
163	168	5	0		9.43	9.43
168	173	5	10	33.10	30.65	30.70
173	178	5	10	30.65	26.20	26.35
178	183	5	0		5.78	5.78
183	188	5	0		5.12	5.12

Diamond drill hole No. DH-28

Location: 200' S. and 100' E. of N.W. corner Maggie No. 13
Altitude of collar: 2,532 feet — Depth: 295 feet
Started: 4/20/40 — Finished: 4/30/40

Footage			Percent core	Percent manganese		
From	To	Feet	recovery	Core	Sludge	Combined
240	244	4	0		1.9	1.9