MANGANESE DEPOSITS OF WESTERN ARIZONA

BY L. L. FARNHAM AND L. A. STEWART

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MANGANESE DEPOSITS OF WESTERN ARIZONA[1]

BY

L. L. FARNHAM[2] AND L. A. STEWART[2]

Summary and Introduction

THIS PAPER is one of a series concerning the mineral resources of the Nation. It briefly describes most of the various known manganese deposits of western Arizona, which for the purpose of this report is considered to include the counties of Coconino, Maricopa, Mohave, Yavapai, and Yuma. With very few exceptions, these descriptions are the result of field examinations by the writers.

The location of the deposits is described by section, township, and range in surveyed areas and by approximate projections of these subdivisions in unsurveyed areas. The township and range numbers refer to the Gila and Salt River base and meridian.

This investigation was begun in March 1954, and during the following 2 years a total of 115 deposits had been examined. The distribution of deposits by counties is as follows: 7 in Coconino, 23 in Maricopa, 32 in Mohave, 11 in Yavapai, and 42 in Yuma.

The history, production, ownership, geologic setting, and mining methods are discussed for most of the deposits visited. Some deposits may have been overlooked, but all the principal ones have been examined. Some of the smaller deposits probably have been worked out since they were visited, as most of them were producing when examined.

The Bureau of Mines plans to describe the manganese deposits in the remainder of the State in a later publication.

[1] Work on manuscript completed April 1956.

[2] Mining engineer, Southwest Experiment Station, Bureau of Mines, Tucson, Ariz.

ACKNOWLEDGMENTS

All owners and lessees of the manganese properties were very cooperative in conducting the authors over their deposits and in furnishing information about them. Special acknowledgment is due the late R. I. C. Manning, Director of the Arizona Department of Mineral Resources, and his engineers for help in locating many of the deposits in the field.

The Bureau of Mines has endeavored to contact the owners of all deposits visited for the purpose of obtaining permission to publish the information. Owing to changes of addresses a few may have been missed.

PHYSICAL FEATURES AND CLIMATE

Arizona is divided physiographically into the Colorado Plateau region in the northeast and the Basin and Range province in the south and west. The latter is divided into the Mountain region and the Desert region (fig. 1). The Desert region of the Basin and Range province covers Yuma and much of Maricopa County, the Mountain or Highland region covers the lower parts of Mohave and Yavapai Counties, and the Colorado Plateau region covers upper Mohave and Yavapai Counties and virtually all of Coconino County.

The Desert region is characterized by numerous mountain ranges separated by plains or valleys. The ranges usually trend northwest to north, roughly parallel to the edge of the plateau, and rise abruptly from plains or valleys. These mountains generally are low, narrow, and very steep and support only sparse vegetation. Broad desert plains probably form

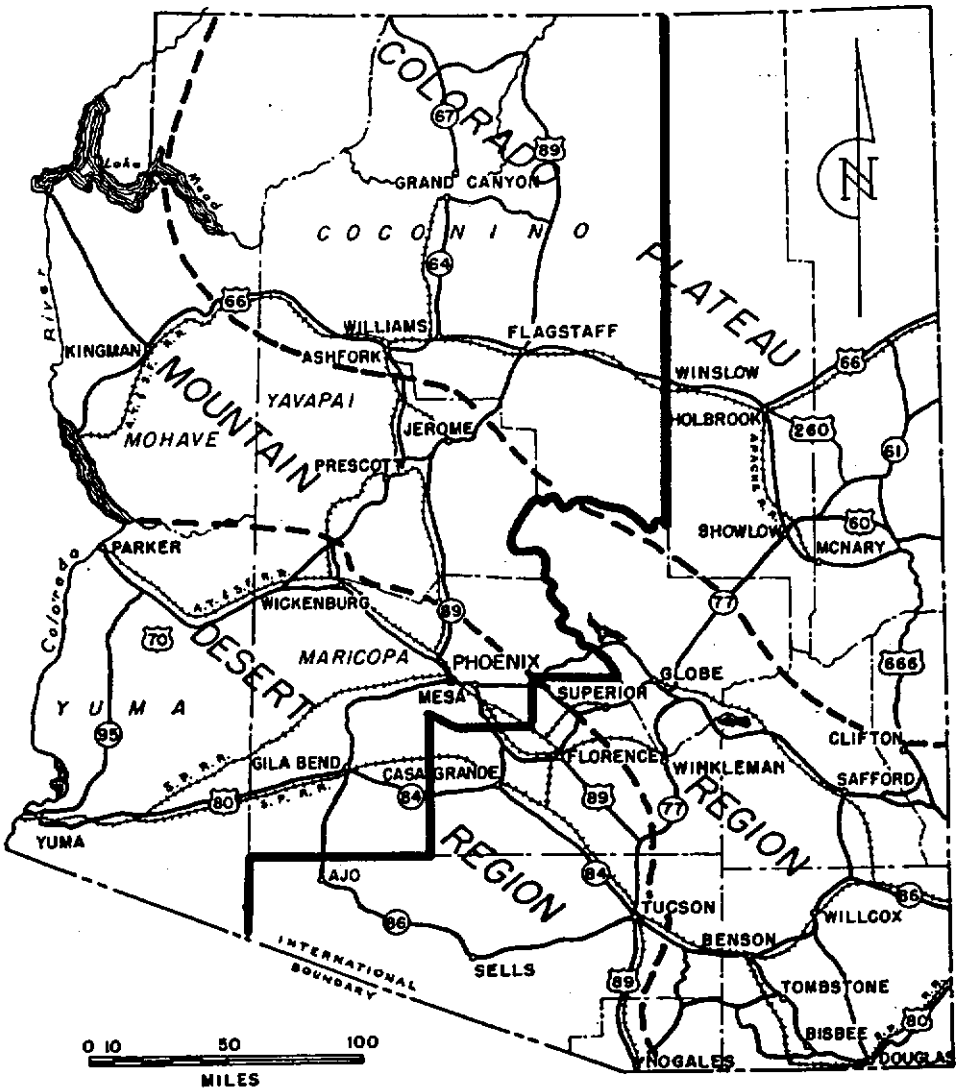

FIGURE 1.—Map of Arizona.

over half of this region. The climate [3] is very hot and dry; the annual precipitation in the Yuma area averages only 3.70 inches, whereas Phoenix, farther east, averages 7.76 inches.

In the Yuma Valley the mean maximum temperature is 86.7° and the mean minimum 52.3° F.; the highest temperature was 117° and the lowest 14°. At Phoenix these temperatures are 84.3°, 56.2°, 118°, and 16°, respectively. The altitude at Yuma is 138 feet; Phoenix is 1,107 feet above sea level.

The Mountain region forms a belt some 60 to 100 miles wide between the Desert and Plateau regions and is composed chiefly of mountain ranges with a few broad plainlike valleys. The climate is cooler than that of the Desert region, as the altitude is considerably higher. Annual precipitation at Prescott is 18.76 inches and at Kingman 11.14. At Prescott the mean maximum temperature is 69.7° and the mean minimum 35.6°; the highest temperature was 110° and the lowest −21°. At Kingman these temperatures are 76.8°, 46.1°, 117°, and 6°, respectively. Most of the higher mountains in this region are covered with timber. The altitude at Prescott is 5,389 feet and at Kingman 3,453 feet.

The Colorado Plateau region is composed essentially of a broad rolling plateau cut by many deep canyons. The climate is cool, as the average altitude probably is over 6,000 feet. Annual precipitation at Flagstaff is 21.12 inches from rain during the summer and considerable snow during the winter. Annual precipitation at Grand Canyon is 16.71 inches. The mean maximum temperature at Flagstaff is 60.8°, the mean minimum 30.9°, the high 102°, and the low −30°. At Grand Canyon these temperatures are 62.3°, 34.2°, 103°, and −22°, respectively. The altitude at Flagstaff is 6,907 feet and at Grand Canyon 6,930 feet. Much of the plateau is covered by a large pine forest.

[3] Smith, H. V., The Climate of Arizona: Univ. of Arizona Agr. Exp. Sta., Bull. 197, July 1945, 112 pp.

HISTORY AND PRODUCTION

The occurrence of manganese in Arizona has been known for many years, but evidently no production was recorded until 1915, when manganese ore as such was mined in the Tombstone, Bisbee, and Globe regions.[4] Before that date it had been mined with the silver ores and used as a smelter flux. During 1916, 1917, and 1918 considerable manganese ore was produced (table 1), but after World War I production dropped. In the 1920's most of the production came from the Bisbee area; a small amount came from the Long Valley region of Coconino County and some from the Artillery Mountains region of southern Mohave County. This tapered off in 1930–31, and during the depression years 1932 through 1939 no ore whatever appears

TABLE 1.—*Arizona manganese production*

Year	Long tons			County
	10–35 percent	Over 35 percent	Total	
1915	[1] 1, 452	339	1, 791	Cochise.
1916	[1] 7, 392	3, 060	10, 452	Do.
1917	[1] 19, 053	14, 802	33, 855	Do.
1918	[1] 6, 758	17, 612	24, 370	Cochise, Maricopa, Pinal, Yuma, and Santa Cruz.
1919	[1] 1, 964	529	2, 493	(?).
1920	[1] 345	2, 402	2, 747	(?).
1921	0	328	328	(?).
1922	0	203	203	(?).
1923	0	245	245	(?).
1924	0	42	42	(?).
1925	0	294	294	(?).
1926	46	2, 684	2, 730	Cochise.
1927	179	3, 905	4, 084	Do.
1928	214	3, 507	3, 721	Cochise, Maricopa, Mohave, and Coconino.
1929	45	2, 655	2, 700	Cochise, Maricopa, and Coconino.
1930	48	364	412	Cochise and Mohave.
1931	0	40	40	Maricopa.
1932–39	0	0	0	
1940	0	311	311	Cochise, Coconino, Mohave, and Yavapai.
1941	15	904	919	Gila, Pinal, and Mohave.
1942	0	2, 630	2, 630	Mohave, Coconino, and Gila.
1943	7, 989	5, 160	13, 149	Do.
1944	285	7, 606	7, 891	Mohave, Gila, Cochise, Coconino, Pima, Yuma, Yavapai, and Santa Cruz.
1945	50	975	1, 025	Pima, Coconino, Yavapai, and Mohave.
1946	0	0	0	
1947	55	118	173	Coconino.
1948	0	214	214	Do.
1949	0	208	208	Do.
1950	0	198	198	Coconino and Gila.
1951	200	154	354	Do.
1952	0	181	181	(?).
1953 [2]	102, 546	1, 414	103, 960	Virtually all counties.
1954 [2]	137, 884	1, 817	139, 701	Do.
1955 [2]	109, 091	13, 979	123, 070	Do.
Total	395, 611	88, 880	484, 491	

[1] Used chiefly for smelter flux.
[2] Wenden and Deming stockpiles only. In addition, several hundred tons containing over 40 percent manganese were shipped on the "carlot" program in 1953. The 1955 figures are for 11 months through November.

[4] Wilson, Eldred D., and Butler, G. M., Manganese Ore Deposits in Arizona: Arizona Bureau of Mines, Bull. 127, February 1930, pp. 31–32.

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to have been produced. Mining again was begun in 1940, when 311 long tons was produced. Production then increased to 13,149 long tons in 1943 (this included 445 long tons of fluxing ore and 7,544 long tons of mill ore). Most of the ore was produced in Mohave, Coconino, and Gila Counties.

An output of 7,891 long tons was recorded in 1944, but after World War II it again dropped, ranging from zero in 1946 to only a few hundred tons annually through 1952.

In January 1953 General Services Administration opened a manganese purchasing depot at Wenden, Ariz. (another depot had been opened at Deming, N. Mex., in November 1951).

Purchase of manganese ores containing 15 percent manganese (Mn) or more by these depots accelerated production, so that during the period 1953–55 the 2 depots received from Arizona 349,521 long tons of ore containing 15 to 35 percent Mn and 17,210 long tons containing over 35 percent.

The Wenden depot was closed in May 1955, but the Deming depot remained open through November 1955. The nationwide "carlot" program of General Services Administration for purchase of domestic manganese ore of metallurgical grade at shipper's railhead became available in July 1952 and is still an available market.

Table 1 gives the Arizona production from 1915 through November 1955. The data through 1952 were taken from Mineral Resources of the United States and Minerals Yearbooks. The figures for 1953 to 1955, inclusive, are from the GSA purchasing depots' records and represent shipments to the Wenden and Deming depots. These tonnages will not be considered production for Minerals Yearbook purposes until shipment is made in usable form from the depots.

DESCRIPTION OF DEPOSITS

Since the appraisal study was concerned primarily with the evaluation of manganese deposits in Arizona as to size and productivity, detailed classification of the manganese minerals in the different deposits by time-consuming and elaborate X-ray analysis, microscopic examination, or chemical analysis was considered beyond the scope of this paper. To expedite the investigation, therefore, the manganese minerals in the samples from the numerous deposits were classified by visual examination of hand specimens. The guide used in the field for classifying the manganese minerals was as follows:

Wad was used as the generic term for soft, colloidal mixtures of hydrous manganese oxides with clay and iron oxides. Pyrolusite, MnO_2, was identified as material that had a high specific gravity, massive appearance, metallic luster, black streak, and the characteristic property of soiling the fingers when rubbed. The term "psilomelane" was used to designate the hard manganese oxide minerals that occurred in massive concretionary or botryoidal forms. Manganite, MnO(OH), was restricted to prismatic crystals that filled vugs or formed feltlike masses of small crystals in other manganese oxides.

COCONINO COUNTY

Coconino County has comparatively few known manganese deposits, and these occur in the widely separated southern corners of the county (fig. 2). The principal occurrences in the southeastern corner lie along the southern edge of the Mogollon Plateau in the Long Valley area and in the region extending southeast almost to the Navajo County line. So far as known, only one other productive deposit has been found in other parts of Coconino County. This deposit, known as the Johnson and Hayden property, is near the southwestern corner, some 25 air miles northwest of Seligman, Ariz.

LONG VALLEY DEPOSITS

Manganese mineralization in the Long Valley district occurs within a northeasterly trending area roughly 2 miles long and as much as one-half mile wide. The area covers parts of secs. 19, 20, 29, and 30, T. 14 N., R. 10 E. It is about 54 miles south of Flagstaff and about the same distance southwest of Winslow. These towns are the district's nearest railroad shipping points. Clints Well, also known as the Long Valley store, is about 2 miles southeast of the deposits. The graveled Flagstaff-Pine road passes through the central part of the mineralized area. (See fig. 3.)

The district lies on the Mogollon Plateau in an area of low to moderate relief. Altitudes range from about 6,900 to 7,200 feet above sea level. Frequent summer rains and heavy winter snows furnish the annual precipitation, which amounts to about 25 inches. From late October to mid-April the roads often are blocked by snow, which usually restricts mining operations to about 6 months of each year. The region is covered with a heavy growth of yellow-pine timber, and logging is the principal industry during the summer and late fall. Water is obtained from scattered springs, shallow wells, and artificial tanks or reservoirs, which collect the runoff water behind earth-filled dams.

The manganese deposits in the area occur principally as small, irregular bodies distributed erratically within gently dipping beds of the Kaibab limestone. Other minor occurrences have been found as accumulations in soil and detrital material. The ore-bearing limestone crops out in places along the sides of some of the deeper ravines. The overburden varies in thickness, ranging in the developed area from a few feet to as much as 60 feet. The majority of the deposits in the limestone are small, disconnected, lenticular masses more or less conforming to the strike and dip of the enclosing limestone. The individual ore bodies, composed of the higher grade manganese oxides, range in size from those containing a ton or so of ore to some that are said to have yielded as much as a hundred tons. The ore mined in the limestone seldom has exceeded a maximum thickness of 2 feet.

The principal ore minerals are psilomelane and pyrolusite. The gangue consists essentially of soft, sandy limestone and iron oxides.

The ore occurring near the surface was mined in opencuts and pits. Where the overburden was too thick to be readily stripped, the ore was mined in small roomlike stopes developed from adits and shafts. Close timbering of the underground workings was necessary

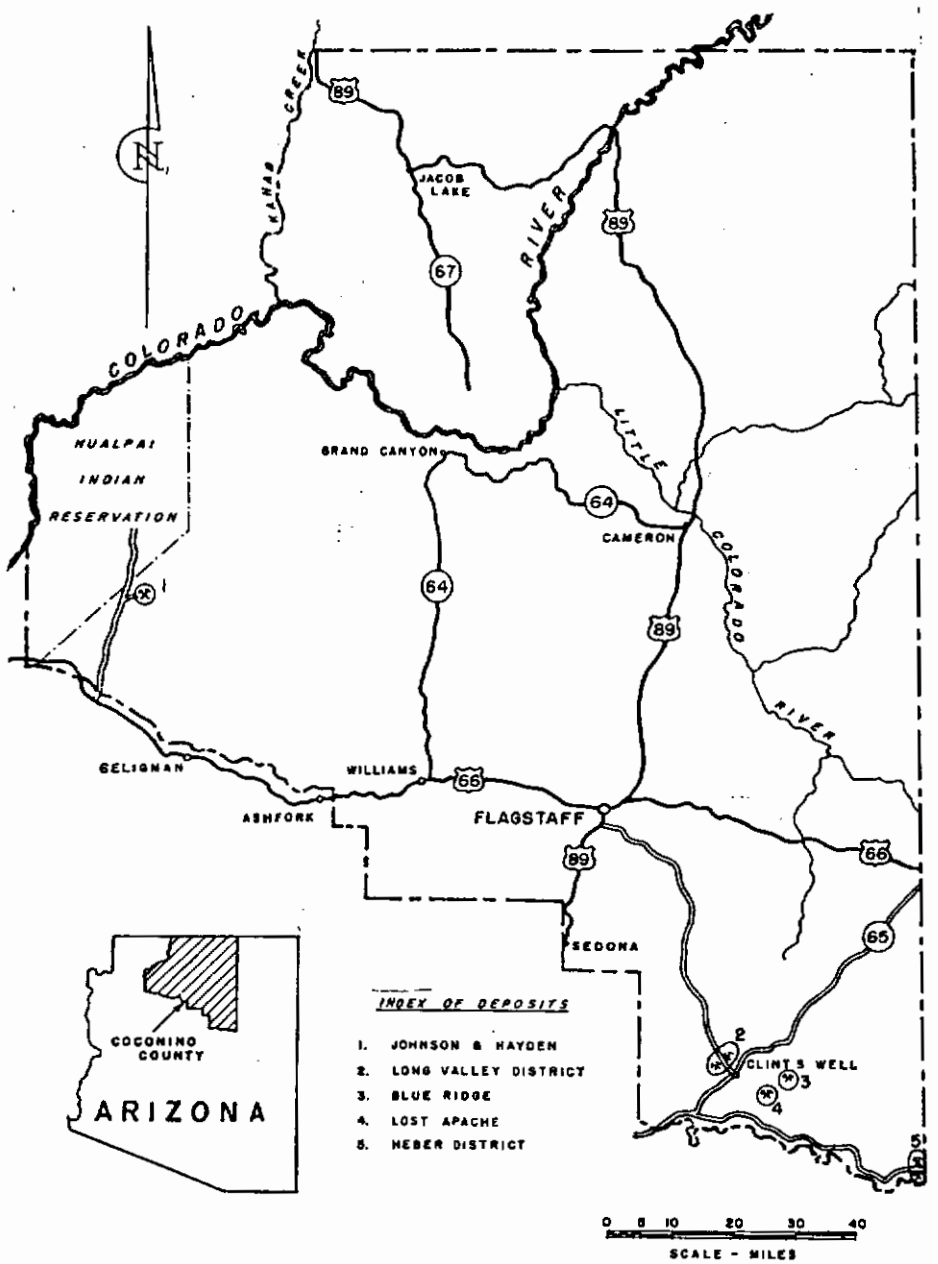


FIGURE 2.—Manganese Deposits of Coconino County.

where the overlying material consisted of soft, sandy, decomposed limestone.

Other less important occurrences in the area consist of small, scattered pods of ore, appearing as replacements in the residual clayey soil and as placerlike accumulations of the harder manganese minerals in the detrital material resulting from the erosion of the original deposits. This detrital manganese ore, consisting largely of nodules and fragments of psilomelane, is rather widespread in scattered areas throughout the district. It has been explored, as well as mined, in some parts of the area and has yielded most of the jig concentrates.

HISTORY AND PRODUCTION

The manganese deposits in the Long Valley region, though known much earlier, received little if any attention until 1917. Since that time they have been worked intermittently by various operators. The period of greatest activity followed the outbreak of the Second World War. At that time many of the older

claims were relocated and consolidated into two separately owned groups that cover the larger part of the known mineralized area. These two groups are owned by the Denison Manganese Co., of Batesville, Ark., and L. E. Shoup, of Prescott, Ariz.

Available information concerning the earlier production from the district is meager and in some cases contradictory. The more reliable estimates indicate that up to 1954 the production from the area totaled approximately 3,300 tons of sorted ore, containing 40 percent or more manganese, and some 700 tons of jig concentrates, averaging 32 to 42 percent manganese.

DENISON GROUP

The Denison property comprises nine patented claims largely in the W½ sec. 30, T. 14 N., R. 10 E. The group covers the southwestern portion of the principal productive deposits in the district and includes many of the earliest locations formerly known as the Black Diamond, McCloskey, and Linesba claims. The property is accessible over a short road that branches west from the main Flagstaff road about 1.5 miles north of the Long Valley store.

The history and production of the property before 1927 is not well known. According to local information, there was some mining

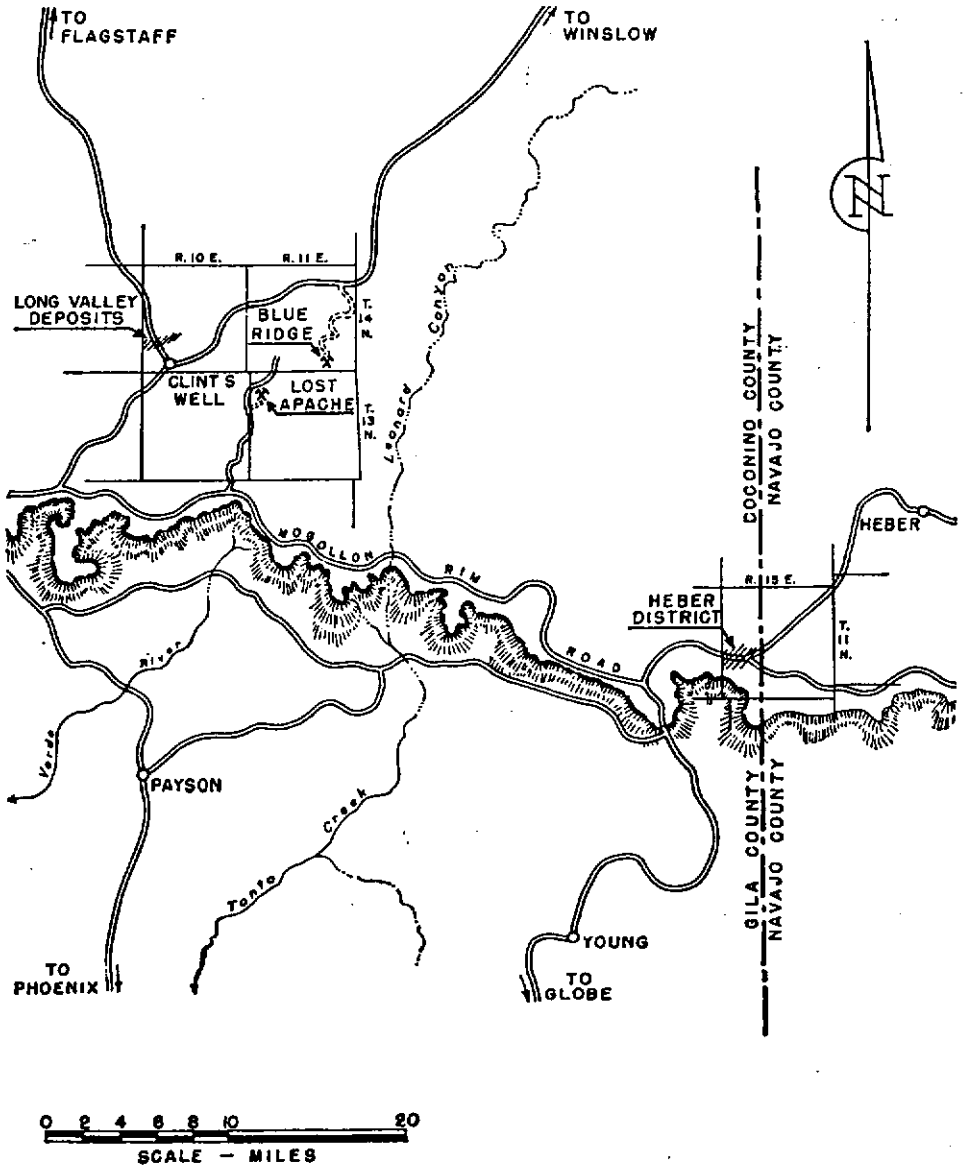


FIGURE 3.—Manganese Deposits of Southeastern Coconino County.

activity during World War I; a small amount of ore may have been produced during that period, although it was not officially recorded. Activity was resumed in 1927, when some of the claims were relocated by Ben W. McCloskey, who during the following 2 years shipped about 216 tons of ore containing 45 to 48 percent manganese. Apparently, the property was not active again until 1940, when W. W. Linesba reportedly shipped about 200 tons of ore containing somewhat more than 40 percent manganese. Later in that year the claims were acquired and subsequently patented by the Reed Denison Manganese Co. This company operated the property until 1950 and, according to J. Reed Denison, produced during that period some 2,200 tons of ore averaging close to 45 percent manganese. In 1952 the property was leased to the Bosley Mining Co., of Flagstaff, Ariz. This company in conjunction with Al Stovall, of Phoenix, Ariz., built a jig plant at the south end of Mormon Lake, where water was available. During 1952 and 1953 the Bosley Co. mined and concentrated several thousand tons of manganese-bearing soil and detrital material occurring on the property and at the same time produced about 350 tons of sorted ore from the deposits in the limestone. The detrital material was trucked some 28 miles to the mill at Mormon Lake, where after washing and crushing it was concentrated in diaphragm-type jigs. Some 700 tons of jig concentrates was produced before the plant was dismantled in 1954. The 1953 output of ore and concentrates was shipped to General Services Administration, some on the carlot program and some to the Wenden purchase depot.

Thus, the available records indicate that the total production from the Denison property up to 1954 has been about 3,700 tons of ore and concentrates, all of which probably averaged about 40 percent manganese. When the district was visited in August 1954, the Denison and Shoup properties were leased to Don C. Adams and Howard Mottier, who were producing ore from the southwestern part of the area.

The manganese-bearing limestone on the Denison claims was exposed in numerous pits and adits scattered over a length of some 1,500 feet along the sides of an arroyo trending northwest, known as Iron Mine Draw. Most of the older workings had caved. The largest and probably the most productive of the accessible workings consisted of an open pit about 200 feet long and 30 to 100 feet wide. The impure sandy limestone in which the ore occurred was exposed around the lower part of the pit. Several adits driven in the mineralized bed extended outward in various directions from the sides of the pit. The manganese oxides in these openings occurred as thin parallel seams and in short, disconnected lenses that generally were conformable to the gently dipping bedding planes of the enclosing limestone. In places the bed was mineralized to a limited extent over a maximum thickness of 8 feet. In other adjacent areas there was no evidence of manganese minerals. At the time of the visit (August 1954) lessees were mining ore from a slightly inclined adit that followed a lens of ore exposed on the north side of the pit. This lens ranged from 6 to 10 feet in length and 0.5 to 3 feet in thickness and had been followed along the dip for about 12 feet.

The manganese-bearing detrital material from which the jig concentrates were recovered was mined from several areas along the side of Iron Mine Draw. The contained manganese minerals consisted of modules and fragments ranging in size from grains of wheat to masses several inches in diameter. About 7,000 tons of this detrital material was mined in open pits with a power shovel. The larger excavations were 50 to 100 feet long, 10 to 20 feet wide, and in places 15 feet deep. According to Don C. Adams, a large part of the mined material contained about 10 percent manganese.

SHOUP GROUP

The Shoup property, comprising 14 lode claims, 4 of which are patented, adjoins the Denison group in sec. 30 and extends northeast in parts of secs. 19, 20, and 29, T. 14 N., R. 10 E. The Flagstaff-Pine road passes through the southwest end of the property.

Little is known of the history of the claims before 1939, when they were acquired by L. E. Shoup, of Prescott, Ariz. The production from the property, according to Shoup, has aggregated about 600 tons of high-grade sorted ore, most of which was mined during World War II.

The exposed manganese occurrences on the claims are similar to those found on the Denison property. The ore-bearing Kaibab limestone is exposed in a few places at the extreme southwestern end of the property but is covered by overburden to the northeast.

The claims were explored by numerous scattered pits, opencuts, and two vertical shafts. The shafts are in the southwestern part of the property, several hundred feet from the outcrops of the ore-bearing limestone. They were inaccessible at the time of the visit but were reported to be 60 to 70 feet deep. Both are said to have penetrated 6 to 8 feet of manganese mineralization at a depth of about 50 feet. The area to the northeast, between the shafts and main road, had been explored in 1941 by extensive trenching. The larger trench, evidently excavated with a power shovel, ranged from 200 to 500 feet in length and from 20 to 50 feet in

width. None exceeded 20 feet in depth, and so far as could be determined all had apparently bottomed in detrital material. The material removed from the excavations contained varying amounts of manganese fragments. Whether this exploratory work was done to sample the manganese-bearing soil and detrital material or to reach and explore the underlying limestone is not known. The claims northeast of the Flagstaff road had been explored by numerous shallow pits and opencuts. More or less fragmental psilomelane was present in the soil and detrital material removed from these openings.

Since the visit of August 1954 a 1,000-foot water well has been drilled on the property and is reported to have produced 125 gallons per minute when tested.

BLUE RIDGE CLAIMS

The Blue Ridge property, comprising 2 unpatented claims, is in sec. 35, T. 14 N., R. 11 E., about 8.5 air miles due east of the Long Valley deposits. The claims can be reached over 6 miles of a poor road that branches south from the Winslow road about 4 miles north of the Long Valley store.

The claims were located originally in 1940. When the area was visited in August 1954, the property was held by Dennis Echol, of Winslow, Ariz. According to local information, a few tons of sorted ore was produced during 1942.

High-grade manganese oxide minerals occurred on parts of the property as surface float and in small lenses or pockets in the soil overlying a sandy, decomposed limestone. The principal workings consisted of a few scattered opencuts. The larger of these openings was about 10 feet long, 6 feet wide, and 5 feet deep. A flat-lying lens of ore exposed in the face of this cut was about 4 feet long and 2 to 8 inches thick. It was about 3 feet below the surface and apparently was surrounded by soft soillike material. Similar but smaller pods of manganese oxides were found in places along the sides of another nearby opencut.

Other deposits of a like nature are reported to occur on Blue Ridge, about 4 miles northeast of the Long Valley store. These could not be found when the area was visited in August 1954.

LOST APACHE CLAIM

The Lost Apache is an unpatented claim in sec. 7, T. 13 N., R. 11 E., about 5.5 air miles southeast of the Long Valley deposits. The claim may be reached by driving 12 miles south from the Long Valley store, thence about 6 miles east over the Mogollon rim road to the Battleground Ridge road, and north over the latter road for 6 miles. At this point the deposit is about 1,000 feet south of the Battleground road.

The claim was located and explored in 1949 by H. E. Jensen, of Winslow, Ariz., and relocated in 1952 by Jerold C. Bosley, of Flagstaff, Ariz. The production has aggregated a few tons of ore consisting of lumps of manganese oxide, which were handpicked out of the soil excavated from shallow pits and cuts.

In the explored part of the claim fragments and nodules of manganese oxide were evident on the surface over an area several hundred feet square. Boulderlike masses of psilomelane weighing up to 10 pounds were said to have been found in the soil during the course of the work. The exploratory openings consisted of shallow pits and trenches, evidently excavated with a bulldozer. In places the soil contained more or less manganese to depths of several feet. Solid bedrock did not appear to be exposed in any of the excavations.

HEBER DISTRICT

The Heber district is in the extreme southeastern corner of Coconino County about 17 miles by road southwest of Heber. The principal manganese claims in the area cover parts of secs. 17, 18, 19, and 20, T. 11 N., R. 15 E., and are accessible over the Young-Heber road, which passes through the central part of the district. Snowflake, Ariz., some 50 miles to the northeast, is the nearest rail shipping point.

The area lies on the well-forested Mogollon Plateau at an altitude of about 7,000 feet above sea level. The relief is moderate, and climatic conditions are similar to those of the Long Valley region some 35 air miles to the northwest. Mining operations are seasonal because the roads usually are blocked with snow during the late fall and winter months. Water is limited to that obtained from scattered springs and artificial tanks.

The first claims in the area were located in 1944 by Johnny Patrick, of Overgaard, Ariz. Later, Alvis F. Denison, of Albuquerque, N. Mex., became interested in the district and eventually acquired by purchase and location approximately 80 lode claims comprising groups known as the Mesa Verde, Hill Crest, Campbell, and Denison. Denison applied for patents to cover about 40 of these claims in 1953. The United States Forest Service protested the issuance of a patent on some of the claims, and a hearing was held late in 1953. So far as known, the matter was still pending before the Bureau of Land Management in August 1954. The other principal group of claims in the area, known as the Rainbow, was held by Johnny Patrick.

According to estimates made by Patrick, production from the district to the end of 1953

totaled about 600 tons of ore containing 40 to 45 percent manganese. The early production was shipped to the stockpile of the Metals Reserve Corporation at El Paso, Tex., and that during the last 2 years was shipped to purchase depots of the General Services Administration at Deming, N. Mex., and Wenden, Ariz. The records show that during 1953 some 87 tons of ore averaging about 37 percent manganese was sold by Alvis F. Denison to the purchase depots. According to Patrick, about half of the ore shipped in 1953 was produced by himself from the Rainbow claims and shipped in Denison's name. Patrick also stated that his production through 1953 from the Rainbow group had totaled approximately 260 tons of ore averaging about 40 percent manganese. All of this ore was shipped in the name of either the J. Reed Denison Manganese Co., of Long Valley, or Alvis F. Denison.

The ore produced in the district occurs as fragments and masses of manganese oxide found scattered sporadically through the clayey residual soil overlying the gently dipping Coconino sandstone. Manganese oxides also occur as seams along bedding planes and in fractures within the sandstone. However, these bedrock occurrences were but slightly explored and had not been productive. The ore in the soil is largely psilomelane in fragments ranging in size from small particles to irregular angular masses, a few of which are said to be as much as 2 feet in their greatest dimension. The ore produced to date has been found within a few feet of the surface and recovered from scores of pits and cuts that are widely scattered over most of the claims. The amount of ore varies greatly from place to place and appears to be localized in bunches that contain from a few hundred pounds of ore fragments to larger accumulations that are said to have yielded up to 20 tons of recoverable manganese. Areas of residual soil where the manganese fragments appeared on the surface in the greatest abundance were the only evident guides to possible underlying accumulations.

The workings in the district ranged from small cuts made with pick and shovel to large pits excavated with a bulldozer. Some of the larger pits were 100 feet or more long, 8 to 16 feet wide, and as much as 10 feet deep. A few of the claims were explored by shafts, the deepest of which was said to be about 60 feet. The ore was recovered by handpicking the larger fragments of manganese oxide out of the soil unearthed in the various excavations. Considerable ore was found on the surface in the form of float.

When the district was visited in August 1954, both the Patrick and Denison properties were being worked on a small scale, and about 75 tons of ore had been produced during the previous 4 months of 1954.

JOHNSON AND HAYDEN DEPOSIT

The Johnson and Hayden manganese property is near the southwestern corner of Coconino County in NW¼ sec. 2, T. 26 N., R. 7 W., on land owned by the State of Arizona. The property is accessible over 17.5 miles of poor road that branches north from United States Highway No. 66 about 20 miles west of Seligman, Ariz. After leaving Highway No. 66, the road follows Aubrey Valley northward for 15.5 miles to an east branch, which leads to the deposit. This branch winds up a canyon trending east for 2 miles in the Aubrey Cliffs and terminates near the deposit at an altitude of about 6,200 feet above sea level. The nearest available railroad shipping point is Nelson, a siding on the Atchison, Topeka & Santa Fe Railway, some 30 miles by road southwest of the property.

The deposit was discovered and slightly explored in 1940 by Don C. Adams and W. J. E. Woody under a prospecting permit issued by the State of Arizona. So far as known, no ore was marketed while the property was held by Adams and Woody, and their permit eventually was allowed to lapse. Interest in the deposit was revived in 1952 and 1953 after establishment of the Government depots at Deming, N. Mex., and Wenden, Ariz., for the purchase of low-grade manganese ore. In that year E. H. Johnson and R. E. Hayden, of Seligman, obtained a mineral lease on the property from the State and during 1952 shipped about 37 tons of sorted ore containing 28 percent manganese to the Deming, N. Mex., purchase depot. Later, the property was subleased to the Bosley Mining Co., which during 1953 produced approximately 275 tons of sorted ore averaging about 24 percent manganese. This ore was shipped to the Government purchase depot at Wenden, Ariz. When the area was visited in August 1954, two men employed by the Bosley Mining Co. were producing small quantities of ore from the deposit.

Manganese mineralization on the property occurs within a steeply dipping fracture or brecciated zone cutting the gently dipping beds of the Kaibab limestone. The fracture zone on the surface ranges from 10 to 30 feet in width, strikes northeast, and is exposed in places along the strike for over 1,000 feet. Although manganese mineralization was evident in several places along the outcrop of the brecciated zone, the better mineralized portion appeared to be limited approximately to a strike length of 300 feet and an average width

of 25 feet. The principal workings were confined to this area; they consisted of a centrally located crosscut adit with two short drifts and several pits on each side of the adit. The deepest of these openings was about 40 feet below the outcrop.

The manganese minerals, consisting of a mixture of the common oxides, occur as irregular masses and seams distributed erratically within the brecciated and silicified limestone. The gangue, in addition to unreplaced wall-rock fragments, consisted largely of chert, calcite, and iron oxides.

No regular procedure was followed in mining the ore; the larger and higher grade masses of manganese oxides were gouged out as they were encountered in the exploratory openings. The broken ore was hand-sorted before shipment.

MARICOPA COUNTY

The principal manganese deposits in Maricopa County are in the northwestern part along the low foothills bordering the northern flank of the Big Horn Mountains (fig. 4). In this area, generally known as the Aguila district, a score or more of manganese properties are distributed within a belt about 15 miles long and 4 miles wide trending northeast (fig. 5). The central part of the district is 14 miles south of Aguila. The principal deposits are accessible from this village over graded dirt roads. Aguila, a station on the Parker Branch of the Atchison, Topeka & Santa Fe Railway, is on United States Highway No. 60–70, some 26 miles west of Wickenburg and 22 miles east of the Government manganese stockpile at Wenden, Ariz.

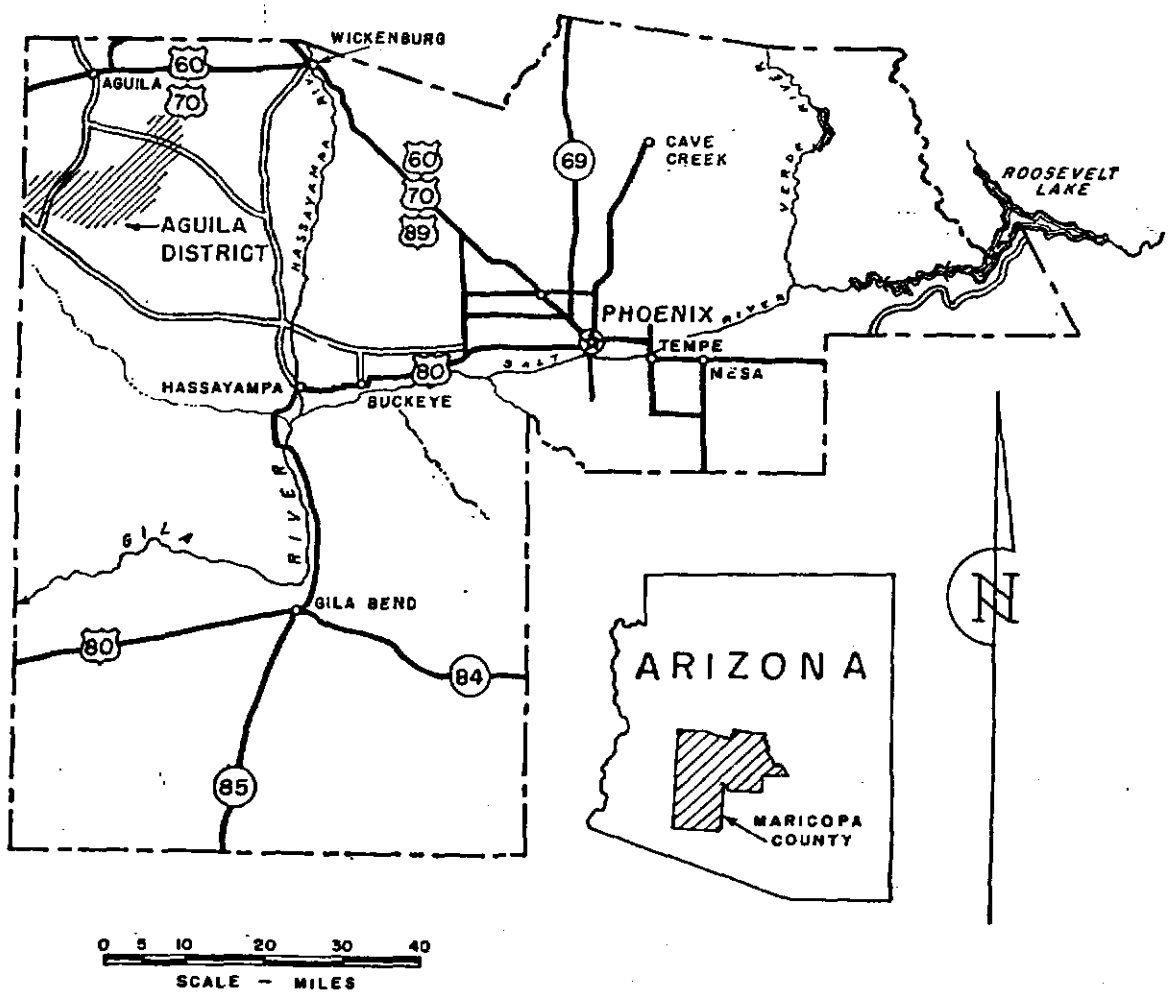
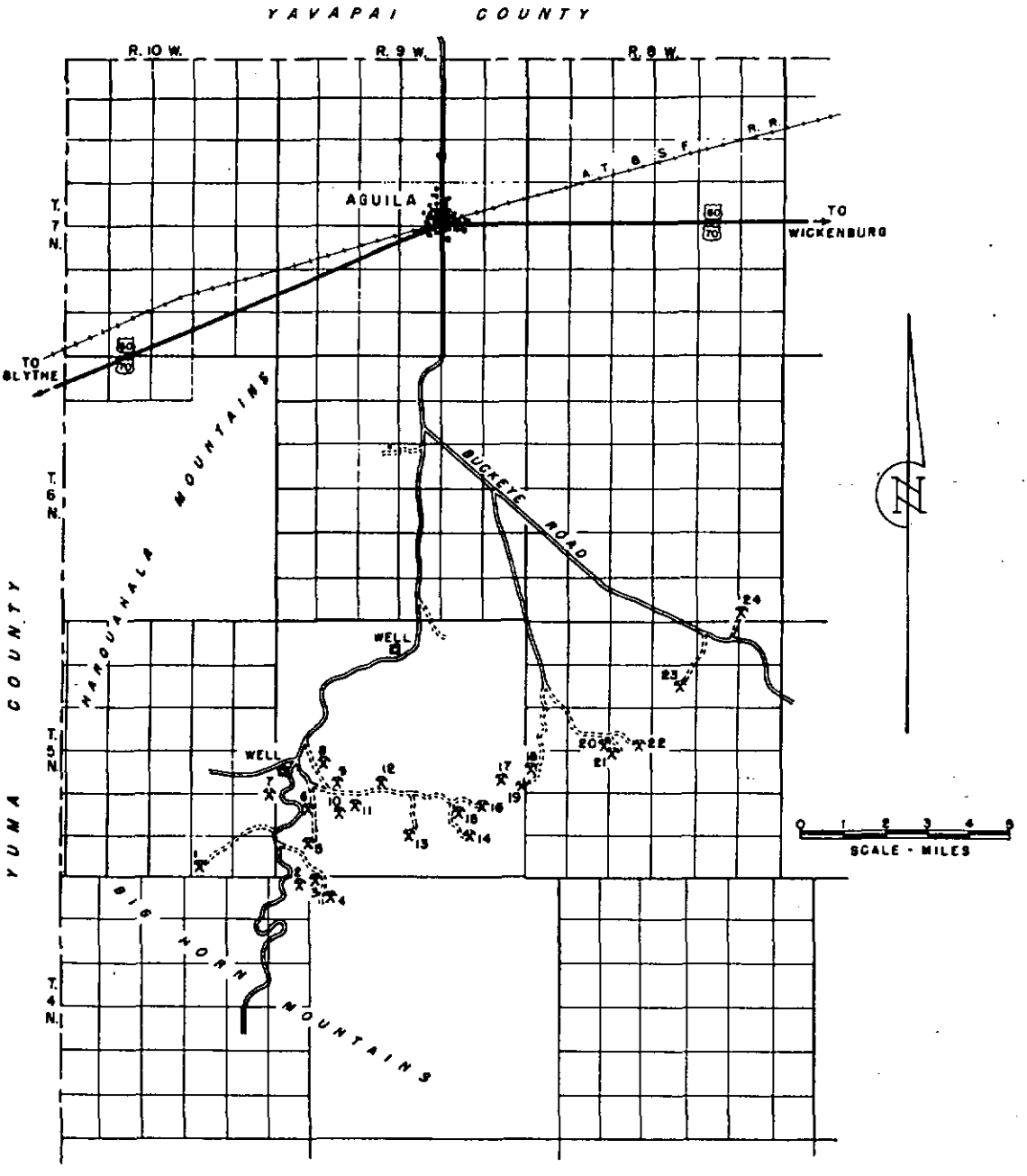


FIGURE 4.—Manganese Deposits of Maricopa County.



INDEX OF MINING PROPERTIES

1. LIONS DEN	9. BLACK NUGGET	17. KAT HEAD
2. BLACK RAVEN	10. APACHE	18. PUMP MINE (GOLD)
3. CROW	11. DULCY	19. PURPLE PANSY
4. KNABE NO. 6	12. ROADSIDE	20. TARNELL
5. BLACK SUE	13. KNABE NO. 4	21. VALLEY VIEW
6. BLACK QUEEN	14. BLACK BART	22. PUMICE
7. WEBB	15. BLACK ROCK NO. 3	23. BLACK CROW
8. AMERICAN	16. BLACK ROCK NO. 1	24. SAMBO AGUILA

FIGURE 5.—Location Map, Aguila District Manganese Deposits.

AGUILA DISTRICT

The area occupied by the manganese deposits is one of moderate relief at altitudes ranging from 2,300 to 2,600 feet above sea level. The climate is arid, and the region supports only sparse desert vegetation. Water is obtainable from a few comparatively shallow wells along a broad valley that bounds the district on the north and west.

Geologically, the area is composed of a basement of older schists and granitic rocks overlain in part by later flows of andesite and light-colored tuffs. The younger flow rocks, where present, vary greatly in thickness, depending upon the degree of local erosion. Manganese mineralization is not restricted to any particular type of rock. The known deposits appear to be as prevalent in the older rocks as in the later volcanics. Faulting is quite common in the area and in places has interrupted the continuity of the ore bodies.

The chief manganese minerals are the common oxides, usually occurring as a mixture of pyrolusite, psilomelane, and manganite. The gangue is composed largely of calcite, quartz, and unreplaced fragments of wall rock. The manganese minerals occur as fissure fillings, as irregular masses, and in networks of smaller seams surrounding brecciated fragments of country rock.

The individual deposits range from narrow veins, with small but enriched ore shoots, to wide shear and brecciated zones of lower grade material. The majority of the veins and mineralized fracture zones strike north and dip steeply west.

Before 1952 there was little demand for ore unless it contained 35 percent or more manganese. To meet this requirement it was necessary to restrict the earlier mining operations to the highest grade portions of those deposits that by hand sorting and screening would yield a product containing a minimum of 35 percent manganese. Ore of this character was not extensive and usually was confined to small erratic ore shoots that seldom exceeded 50 feet in length and generally averaged about 2 feet in width. The ore produced from these occurrences was mined largely in surface cuts and shallow pits. Only a few of the older operations used shafts and underground mining methods. Where underground methods were employed, the ore was broken in open stopes supported by a few stulls or pillars. The walls of the veins usually were strong and needed but little support. The deepest mine level in the district was less than 100 feet below the surface. In most of the deposits the better ore apparently gave way to leaner material at depths ranging from 30 to 80 feet below the outcrops.

Late in 1951, when a lower grade manganese ore could be marketed, attention was directed to the larger low-grade deposits for which previously there was no demand. When the district was visited in April 1954, nine of these larger mineralized shear and brecciated zones had been investigated by surface opencuts and pits. Some were inactive, others were being explored, and three were producing. They varied greatly in size and shape. The largest, as exposed on the surface, covered an area about 300 feet square. Others ranged from 10 to 50 feet in width and from 50 to 150 feet in length. Depths attained in the various opencuts and pits ranged from 5 to not more than 25 feet below the surface.

The manganese minerals in these larger deposits were distributed erratically as irregular masses and in a diversified pattern of seams impregnating and surrounding the brecciated fragments of wall rock.

The ore in the larger mineralized deposits was mined in open pits, utilizing bulldozers for stripping and tractor-type power shovels for loading the broken ore into trucks. Blast holes were drilled with wagon drills or hand-held jackhammers. Ore containing 15 percent or more manganese was trucked directly to the Government purchase depot at Wenden, Ariz. Material containing less than 15 percent manganese was trucked to custom concentrating plants at Aguila.

Contract trucking rates in the area averaged about 10 cents a ton-mile. The cost of hauling ore from the central part of the district to Aguila was $1.50 a ton, and the rate to the Wenden stockpile averaged about $3.50 a ton.

Electric power was not available in the mining area. All equipment was driven either by diesel or gasoline engines.

HISTORY AND PRODUCTION

Manganese first was produced in the Aguila area during the latter part of World War I. The district became active in 1917, and by the end of 1919 a total of 3,496 tons of sorted ore averaging 35.8 percent manganese was shipped from the district. No further production was recorded until 1921. In the following 2 years 612 tons containing 43.4 percent manganese was marketed. From 1923 to 1943 there was little if any activity in the district. With the increased demand for manganese occasioned by World War II, several mines were reopened, and some ore was produced in 1943 and 1944; the actual amount is not known definitely, but it probably was less than 200 tons. All opera-

tions were terminated in 1944, and the district remained dormant until the latter part of 1951.

According to available records, the total production from the Aguila district up to the latter part of 1951 was approximately 4,300 tons of ore containing 35 to 43 percent manganese.

Activity in the district was renewed late in 1951, following the announcement of the Government's purchase program for domestic manganese ore. Nearly all of the old properties were reopened, and exploration was begun on several of the larger low-grade deposits, which formerly had been unattractive.

During 1951 the first custom mill for the concentration of the district's manganese ores was constructed at Aguila by the U. S. Manganese Corp. This plant, relying solely upon relatively coarse crushing followed by jigs, was unable to obtain a satisfactory recovery of the manganese and after treating several thousand tons of low-grade ore was closed late in 1952.

In January 1953 the Government purchase depot at Wenden, Ariz., was completed and began buying ore containing as little as 15 percent manganese. In the meantime, exploration work in the district had indicated an appreciable tonnage of manganiferous material somewhat lower than the minimum acceptable grade (15 percent) required by the purchase depot. To concentrate this lower grade material, the Harquahala Milling Co. acquired the flotation mill owned by the Associated Mining Co. This plant had been built at Aguila some years earlier to treat copper ore. After making the necessary changes in the mill flowsheet, the Harquahala Milling Co. began concentration of the lower grade manganese ores by flotation. Ore was accepted from several of the low-grade deposits in the area. The mill operated from October 1953 until January 1954, when it was found that the grade of the flotation concentrate was not satisfactory. In April 1954 the mill was being remodeled, jigs and tables replacing the flotation section. When operating again as a gravity plant, it was expected to have a capacity of about 300 tons of ore a day.

Settlement for the ore treated in the Aguila mills was made on a "split check" basis. Under this plan the mine operator mined and delivered the ore to the mill at his own expense. The cost of milling the ore was borne by the mill operator. The net proceeds resulting from the sale of the manganese concentrates were divided equally between the two parties.

In April 1954 another manganese custom mill was being built by the Thomas Mining & Milling Co. in the northwest corner of the mining area, about 14 miles southwest of Aguila. The plant was said to have a designed capacity of 100 tons of ore a day. After coarse crushing followed by rolls, the manganese in the ore was to be concentrated in jigs and tables. The mill was expected to be completed and in operation by June 1954.

During this period of activity, available information indicates that 30,000 tons of low-grade manganese ore was mined in the Aguila district between the latter part of 1951 and April 1954. About half of this tonnage, averaging less than 15 percent manganese, was concentrated in the 2 mills at Aguila. The other half, containing more than 15 percent manganese, was shipped to the Wenden purchase depot.

SAMBO AGUILA GROUP

This group of eight unpatented claims, owned by Dempsey Powell, of Aguila, is in the southern part of secs. 35 and 36, T. 6 N., R. 8 W., at the extreme east end of the manganese district. The property can be reached over a short side road that branches northeast from the Buckeye road about 15 miles south of Aguila.

The claims originally were located in 1940 and produced a small quantity of ore during the Second World War. In 1951 the property was leased to the U. S. Manganese Corp., which mined 1,500 to 2,000 tons of mill ore during the following year. About half of this tonnage was concentrated in the corporation's jig plant at Aguila. The other half was not treated and at the time of the visit still remained in a stockpile at the millsite. In 1953 the Fisher Construction Co., of Phoenix, obtained a lease on part of the property and completed considerable exploration work during that year. When the area was visited in April 1954, the owners, Dempsey Powell and associates, were mining the higher grade ores from several veins near the east side of the property.

Manganese mineralization occurs on the Sambo Aguila claims in a series of 10 or more fracture zones cutting lavas and light-colored tuffs. The deposits consist of veins and brecciated zones that vary widely in size. The principal manganese minerals are pyrolusite, manganite, and psilomelane.

Ore had been mined from shallow openings on a number of the more prominent exposures. The most extensive workings (in the south-central part of the property) consisted of an opencut or pit that explored a northerly trending shear zone. This opening was about 100 feet long, up to 50 feet wide, and 15 to 20 feet deep. The mineralized zone, as exposed in the north face of the cut, was about 50 feet wide. The walls of the deposit were well defined and appeared to dip very steeply west. The manganese minerals were most abundant along the walls where the shearing was pronounced. The better mineralization bordering the west side of the cut was about 15 feet wide and that along

the east wall about 10 feet. The intervening material, occupying the central part of the zone, consisted of sheared lava containing scattered seams of manganese oxides.

The bulk of the ore produced from the property was mined in this pit during 1952. Heavy mechanical equipment, such as bulldozers and power shovels, evidently was used in mining the ore.

About 500 feet northwest of the large pit a mineralized lens or podlike body had been explored by an inclined opencut. The opening was about 30 feet long and 8 to 15 feet wide and reached a maximum depth of 14 feet. Along the south face of the opening the mineralization was 8 to 12 feet wide. The manganese oxides were distributed irregularly across the face of the cut and in small fractures surrounding the fragments of brecciated wall rock. Some hand-sorted ore had been produced from this opening, but the amount and grade were not known.

A short distance north of the incline a vein trending east and dipping about 20° S. was exposed in an opencut for about 30 feet along the strike. The vein in this distance was 2 to 3 feet wide and in places contained bands of manganese oxides that ranged from a few inches to as much as a foot in width.

Several other exposures of manganese-bearing material on the property had not been explored.

BLACK CROW (ATKINS OR MEADOWS)

This property, formerly known as the Atkins or Meadows, comprises a group of 4 unpatented claims in the central part of sec. 10, T. 5 N., R. 8 W., 2 miles southwest of the Sambo Aguila group. The claims, owned by Mrs. Susie Shorter, of Aguila, are accessible over a side road, slightly over a mile long, that branches south from the Buckeye road about 13 miles south of Aguila.

The property originally was located in 1916 and during the First World War became one of the district's chief producers of high-grade manganese ore. Published records show that production from the property has totaled about 1,200 tons of ore averaging well over 40 percent manganese. No production has been recorded since 1923. In April 1954 the claims were leased to the Aguila Mining & Milling Corp., which was preparing to operate the property.

Ore had been mined from three parallel veins occurring within a shear zone trending west in the older schistose rocks. Granite and gneiss were exposed a short distance east of the shear zone. The veins were 50 to 250 feet apart and ranged from 2 to 5 feet in width. All appeared to dip steeply south. When the property was visited in April 1954 virtually all the underground workings were caved or otherwise inaccessible.

According to some of the older residents of the district, the east vein was developed by an inclined shaft about 70 feet deep. The best ore in the vein was found above the 50-foot level in a lenticular shoot about 80 feet long. The other principal deposit (in the west vein) was mined from a 50-foot shaft, where the ore body was about 40 feet long. Other disconnected outcrops of manganiferous material occurring along the west trend of the shear zone had been explored by cuts and trenches, but no mining had been attempted.

PUMICE GROUP

This property, comprising a group of eight unpatented mining claims, is in a school section owned by the State of Arizona. The claims cover part of the south half of sec. 16, T. 5 N., R. 8 W., and were leased from the State by Roy Cornett, of Congress, Ariz. The property is about 15 miles southeast of Aguila and can be reached over a road that branches south from the Buckeye road 7 miles south of Aguila.

The claims were located in 1952, and during the following year several hundred tons of manganese ore was mined and shipped to the Wenden purchasing depot. Early in 1954 the western part of the property was acquired under a sublease by the Metallic Recovery Co., of Aguila, which was engaged in further exploratory work when the property was visited.

Manganese mineralization, in veins and brecciated zones cutting lavas and tuffs, occurs on the claims in several separated areas. In the western part of the property 4 veins, ranging from 2 to 6 feet in width, had been explored along the outcrops by a series of shallow opencuts and an inclined shaft about 25 feet deep. The principal manganese minerals are pyrolusite and manganite, occurring in a gangue of calcite, quartz, and fragments of wall rock.

About 500 feet northeast of the shaft a mineralized fracture zone had been opened by a cut about 30 feet long, 20 feet wide, and 8 feet deep. As exposed in the cut, the black manganese oxides filled fractures surrounding the brecciated fragments of the wall rock. In the immediate vicinity of the opening the mineralized portion of the zone appeared to be about 50 feet wide. Its length and trend beyond the limits of the cut were hidden under a cover of soil and detrital material. About 100 tons of the material broken in this opening was reported to have been shipped for test purposes to the mill of the Manganese Corp. of Arizona at Bouse, Ariz.

Another zone of low-grade manganese mineralization was found in the southeastern part of the property. This deposit consisted of a network of small irregular seams of manganese oxides impregnating a brecciated lava. The

outcrop of the mineralized zone was traceable, more or less continuously, for over 2,000 feet along the top of a low, northerly trending ridge. In places the mineralized portion of the zone was several hundred feet wide. The manganese-bearing fractures ranged from the thickness of a knife blade to several inches. Some of the fractures were quite closely spaced, and in other parts of the breccia they were separated by several feet of unmineralized lava.

Exploratory openings on the deposit were limited to a few scattered shallow pits and an opencut near the north end of the mineralization. The cut was about 75 feet long, 15 feet wide, and up to 20 feet deep. According to Roy V. Waughtel, who supervised the work, grab samples of the broken material removed from the cut averaged about 5 percent manganese.

VALLEY VIEW AND YARNELL GROUPS

The Valley View and Yarnell properties, comprising adjoining groups of six claims each, are held under location by Dempsey Powell and R. W. Yarnell, of Aguila, Ariz. Parts of the two groups were formerly known as the Prieta Chinda, Manganese Development, and Wheeler claims. The property is about 14 miles by road southeast of Aguila and occupies parts of secs. 17 and 21, T. 5 N., R. 8 W.

The claims were located in 1916 and during World War I produced several hundred tons of sorted ore containing 40 to 46 percent manganese. The property became active again in 1943 and during that year shipped about 75 tons of sorted ore containing 39 percent manganese. During 1952 and 1953 lessees produced about 1,000 tons of mill ore from the Valley View group. Several hundred tons was shipped to the Wenden purchasing depot, and the balance was concentrated in the mill of the U. S. Manganese Corp. at Aguila. The properties were not active when visited in April 1954.

The manganese minerals, consisting of pyrolusite, manganite, and psilomelane, occur on the property in four veins cutting an andesite breccia. The veins are 100 to 200 feet apart; all strike west and dip rather steeply south. The principal productive vein, known as the Valley View, occupies the central part of the series. The other veins are less extensive and have not been developed. The Valley View vein is traceable on the surface for over 1,000 feet and ranges from 1 to 10 feet in width. The eastern half of the outcrop lies within the Valley View claims, and the western half, after crossing a prominent ridge, extends into the adjoining Yarnell group of claims.

The higher grade ore, shipped during the World Wars, was produced from several separated ore shoots found on both the eastern and western portions of the Valley View vein. These ore shoots, ranging from 25 to 100 feet in length and from 1 to 4 feet in width, were mined from shallow adits and opencuts.

The more recent work on the eastern part of the property was devoted largely to exploration of a low-grade zone of manganese mineralization along the footwall of the Valley View vein. This work consisted of a trench about 80 feet long that crossed the trend of the zone and an opencut along the vein. From the face of the trench the opencut followed the hanging-wall portion of the vein for about 50 feet. Both openings were 10 feet wide and reached a maximum depth of some 12 feet below the surface. A bulldozer evidently was used to remove the broken material from the excavations. The work exposed a shear zone containing an irregular network of narrow fractures filled with manganese oxides. The mineralized zone in the trench was about 40 feet wide. Its length beyond the opening was obscured by a cover of soil and detrital material. The mill ore produced in 1952–53 was mined from this deposit.

PURPLE PANSY (FUGATT)

The Purple Pansy property, comprising three unpatented claims, is owned by Fred Seifert and L. W. Smith, of Aguila. The property is about 15 miles south of Aguila approximately in unsurveyed sec. 24, T. 5 N., R. 9 W. It may be reached over a road that branches south from the Buckeye road about 7 miles south of Aguila.

The claims were located originally in 1916 and were known at that time as the Fugatt property. Early in 1950 the group was relocated by J. N. House, of Aguila. The present owners acquired the property in 1951. There is no record of any production before 1952. During 1952 and 1953 about 7,500 tons of mill ore was mined from the deposit by Seifert and Smith. Some of this ore was shipped to the Wenden purchasing depot, but the greater part was concentrated in the custom mills at Aguila. When visited in April 1954, the property was producing about 200 tons of mill ore daily.

The deposit consists of innumerable closely spaced veinlets and irregular masses of manganese oxides that occupy portions of an extensive zone of sheared and brecciated andesite. The mineralized zone trends northwest and appears to dip steeply south. It can be traced more or less continuously on the surface for nearly 1,000 feet and evidently ranges from 200 to 300 feet in width.

The principal manganese mineral is pyrolusite, with some psilomelane. The gangue con-

sists essentially of calcite and unreplaced country rock. The manganese-bearing fractures range from thin seams to veinlets as much as 6 inches wide. At some points, where two or more of the mineralized fractures intersect, are irregular masses or bunches of manganese oxides several feet wide. The manganese content of the deposit varies considerably from place to place, depending largely upon how closely the mineralized fractures are spaced.

Mining operations were being conducted near the south end of the deposit in an open pit, which at the time of the visit covered an area about 200 feet wide and 300 feet long. The ore was broken in 2 benches about 200 feet long. The lower bench was approximately 20 feet high and the upper 10 feet. Vertical blast holes spaced 3 to 5 feet apart were drilled along the rim of the benches. A wagon drill, using seven-eighths-inch steel equipped with detachable bits set with tungsten carbide inserts, was used in the drilling. The holes were blasted simultaneously with electric detonators. The broken ore was loaded into trucks by a gasoline-driven front-end loader. Compressed air for the wagon drill was furnished by a diesel-driven portable compressor. A bulldozer was used for stripping a foot or more of overburden and for cleaning the floor of the pit.

KAT HEAD

This property comprises four unpatented claims that were formerly part of the Black Diamond group. The claims are about 16 miles south of Aguila approximately in unsurveyed sec. 24, T. 5 N., R. 9 W. They may be reached over a mile of road that branches west from the graded Purple Pansy road a short distance south of the Pump gold mine.

The claims were located originally during the First World War and may have produced a small amount of sorted manganese ore during that time. The property was relocated in 1952 by the present owner, Northfleet Knabe, of Aguila, Ariz. R. E. Hill, of Wickenburg, Ariz., obtained a lease on 2 of the claims early in 1954 and by mid-April 1954 had mined and shipped 2 lots of hand-sorted ore to the Wenden stockpile.

Manganese mineralization, consisting of pyrolusite and some psilomelane, occurs on the property in two veins cutting andesite. The veins are several hundred feet apart and range from 2 to 4 feet in width. Both strike northeast and dip steeply west. The east vein could be traced on the surface for about 300 feet. The outcrop of the west fracture appeared less continuous. The better mineralized portions of both veins had been explored by shallow opencuts and pits. The most extensive of such openings was an opencut about 50 feet long, 2 to 4 feet wide, and 5 to 10 feet deep. The ore shipped to the Wenden purchasing depot during the early part of 1954 was mined from an opencut on the east vein.

BLACK ROCK GROUP

The Black Rock property, comprising 3 unpatented claims, is about 19.5 miles south of Aguila approximately in unsurveyed sec. 26, T. 5 N., R. 9 W. The property can be reached over 4.5 miles of a road that branches east from the main western road of the district about 15 miles southwest of Aguila.

The claims were located originally in 1916 and probably were known at that time as the Black Warrior group. Although there is evidence of early work, there are no records to indicate that any ore was shipped from the property before 1952. In 1951 J. N. House, of Aguila, relocated the claims as the Black Rock Nos. 1, 2, and 3. Early in 1952 A. R. Buell, of Aguila, acquired claims Nos. 1 and 2 and began exploration and mining operations in March 1952. At the end of March 1954 about 3,000 tons of ore containing 30 to 35 percent manganese had been produced from the No. 1 claim. When the property was visited in April 1954, ore was being produced at the rate of about 250 tons per month. It was trucked directly to the Wenden purchasing depot of General Services Administration.

Manganese minerals, consisting of the common oxides, are found on the claims in several northerly trending fracture zones that range from 2 to 8 feet in width. The east vein, which is the most productive, occurs in the older granitic rocks that occupy the greater part of the No. 1 claim. The other mineralized fracture zones to the west occur in the andesitic lavas overlying the granite. The east vein dips 20° W., and the west vein on claim No. 3 dips 45° E. The east vein has been exposed underground for about 400 feet along the strike. The other mineralized outcrops are less extensive and have been explored only slightly.

The principal vein on claim No. 1 was developed by an inclined shaft, 50 feet deep, and a single level from the bottom of the shaft that followed the vein for about 400 feet. Stopes, ranging from 50 to 100 feet in length and averaging about 5 feet in width, extended to various heights above the level. The ore was mined in open stopes supported by stulls and pillars of lower grade ore. Blast holes were drilled with jackleg-type rock drills. The ore, when blasted in the back of the stopes, fell to the floor of the level. A scraper, powered with a double-drum slusher hoist, was used to pull the broken ore to the bottom of the shaft, where it was shoveled into the skip. After the ore reached the surface, it was placed in piles

near the collar of the shaft; it was then hand-sorted and loaded into trucks with a small power shovel.

The west vein on the Black Rock No. 3 claim had been explored in several places by shallow pits and opencuts. The most extensive opening was an opencut about 100 feet long, 2 to 4 feet wide, and about 8 feet deep. During 1953 lessees produced several hundred tons of mill ore from these various openings. This part of the property was inactive when visited in April 1954.

After the visit of April 1954 Black Rock claims Nos. 1 and 2 were purchased from A. R. Buell by the Mohave Mining & Milling Co.

BLACK BART

The Black Bart property, comprising two unpatented claims, is approximately in unsurveyed sec. 35, T. 5 N., R. 9 W., about a mile south of the Black Rock group. The claims are accessible over a short side road that branches south from the graded road about 1 mile west of the Black Rock shaft.

The claims were located by Ralph Law, of Aguila, in 1953. When visited in April 1954, the discovery work and access roads had been completed, and preparations were being made by Ralph Law and associates to mine ore for shipment to the Wenden stockpile.

Manganese mineralization, consisting largely of pyrolusite and some psilomelane, occurred on the property in three fracture zones trending north and cutting granitic rocks. The veins dip steeply westward and are spaced at intervals of 100 to 700 feet. The central vein of the series was traceable, more or less continuously, for about 200 feet and ranged from 2 to 5 feet in width. The other two mineralized fractures, though not well exposed, appeared to be less extensive.

The manganese oxides in the veins occurred as seams and strands intermixed with unreplaced fragments of wall rock, calcite, and quartz.

The exploratory openings on the claims were limited to a few shallow opencuts and pits. A few tens of tons of ore, sorted from the material broken during the course of the exploratory work, had been produced, but none had been shipped. The operator expected to mine the future ore in opencuts.

KNABE NO. 4

The Knabe No. 4 group comprises 9 unpatented claims about 20 miles south of Aguila approximately in unsurveyed sec. 34, T. 5 N., R. 9 W. The property is accessible over a side road that branches south from the main graded road about 2 miles west of the Black Rock No. 1 mine.

The claims were located by Northfleet Knabe, of Aguila, in 1951 and a short time later were leased to F. A. Sitton and J. E. Robinette. During 1952 and 1953 the lessees mined 10,000 to 12,000 tons of low-grade manganese ore from 2 open pits. The mine material after being crushed was passed through a trommel screen with ¼-inch openings. The coarse screen oversize was rejected as waste, and the fine material passing the screen openings was trucked to the Wenden purchase depot; 1,000 to 2,000 tons of screened material, estimated to contain 15 to 20 percent manganese, was produced in this manner. When visited in April 1954, the property was idle; all the equipment, with the exception of an ore bin and the conveyor trestle, had been removed.

The mineralized material treated in the screening plant was mined from two fracture zones striking north and appearing to dip steeply westward in brecciated granitic rocks. The east zone of mineralization, as exposed in an open pit, was about 60 feet wide and 100 feet long and had been mined to a maximum depth of some 20 feet below the surface. The other mineralized zone, about 70 feet west of the eastern pit, was exposed in an opencut approximately 150 feet long and 20 to 30 feet wide. The deepest part of the cut was about 15 feet below the surface. The surface surrounding both of the excavations was covered with soil or broken rock so it was impossible to determine whether or not the mineralization was more extensive than that shown in the openings. Other manganiferous exposures were noted on some of the other claims in the group, but the work on these was confined to discovery pits.

The manganese minerals in the deposits were the common oxides, pyrolusite predominating. The principal gangue constituents were unreplaced wall rock, calcite, and quartz. The manganese oxides occurred as fissure fillings and irregular masses and in a network of narrow seams surrounding brecciated fragments of country rock. The better mineralization appeared to occur along the walls of the fracture zones, where in places it attained widths of several feet.

ROADSIDE

The Roadside group, comprising 5 unpatented claims, is about 14 miles south of Aguila approximately in unsurveyed sec. 21, T. 5 N., R. 9 W. The property is readily accessible by a short road that branches north from the main graded road about 2.7 miles west of the Black Rock No. 1 mine.

The claims were located by J. N. House, of Aguila, in 1952. Nothing is known of their earlier history or production. In April 1954 the property was leased by J. N. House to

Frank McElrath and associates, of Long Beach, Calif. When the area was visited in May 1954, exploratory work was just getting under way.

The manganese mineralization found on the property occurred in two fracture zones trending north in andesitic lava. The west zone was traceable on the surface for about 100 feet and ranged from 4 to 6 feet in width. The outcrop of the other mineralized zone, which was some 250 feet to the east, was traceable for about 300 feet. In this distance it appeared to range from 20 to 30 feet in width.

The central part of the western outcrop had been explored by an opencut about 30 feet long, 4 to 6 feet wide, and about 10 feet deep. Some sorted ore evidently had been produced from this opening by former operators. At the time of the visit McElrath and associates had started an opencut across the north end of the eastern zone of mineralization. Arrangements to concentrate this ore had been made with the Harquahala Milling Co., of Aguila.

The manganese minerals, largely pyrolusite, occurred as veinlets and seams surrounding the partly replaced brecciated fragments of andesite. In addition to the wall-rock inclusions, calcite was the predominating gangue mineral.

BLACK NUGGET (U. S. GROUP)

The Black Nugget property of two unpatented claims is approximately in unsurveyed sec. 20, T. 5 N., R. 9 W. The claims are accessible over a short side road that branches northeast from the east fork of the main graded road about 15 miles southwest of Aguila.

The property, formerly known as the U. S. group, first was worked during World War I. Published records show that in 1918 the production totaled 222 tons of ore averaging about 39 percent manganese. An additional shipment of 42 tons containing 48.6 percent manganese was recorded in 1924. The claims were relocated as the Black Nugget group in 1939 and may have produced a small amount of ore during the Second World War. After the war the property remained inactive until 1952, when it was acquired by Roy V. Waughtel, of Aguila. Production was resumed late in 1952, and during 1953 and early 1954 several thousand tons of mill ore was produced. Part of this ore was shipped to the Wenden stockpile, and part was concentrated in the custom mill at Aguila.

The ore was mined largely from three veins or fracture zones cutting andesite lava. The veins strike north, dip moderately to steeply, and range from 3 to 10 feet in width. The east mineralized fracture appeared to have been offset into two or more segments by cross faulting. The longest and most productive of these segments was exposed along the surface for about 150 feet. The central vein, lying some 500 feet to the west, had been mined along the strike, more or less continuously, for nearly 300 feet. The west vein, about 100 feet west of the central fracture, was exposed in a series of opencuts for over 200 feet along the strike.

The east fracture had been developed and mined from underground workings extending from an inclined shaft. The shaft was over 100 feet deep, but according to Roy Waughtel the best ore was found in the upper 60 feet of the vein. At the time of the visit the underground work had been discontinued, and ore was being mined from an opencut along the north side of the shaft.

The other 2 veins had been mined in opencuts that reached a maximum depth of some 40 feet. The ore as broken was removed from the cuts by a scraper and a double-drum slusher hoist.

Irregular areas containing a network of narrow fractures filled with manganese oxides occurred in the brecciated andesite surrounding the two west veins. In places this lower grade mineralization covered areas as much as 100 feet wide and was traceable for about the same distance along the strike.

Pyrolusite and some psilomelane near the surface were the principal manganese minerals. Unreplaced fragments of wall rock and calcite were the chief gangue constituents.

BLACK QUEEN (ARMOUR GROUP)

The Black Queen property, comprising 3 unpatented claims, is approximately in unsurveyed sec. 30, T. 5 N., R. 9 W., and is accessible over a mile of a side road that branches south from the east fork of the main road about 14.5 miles southwest of Aguila.

The claims were located originally in 1916 and were known at that time as the Armour group. During 1917–18 the property was credited with a production of about 1,600 tons of ore containing 35 to 40 percent manganese. The mine was closed in 1918 and was not worked again until the Second World War, when a relatively small quantity of ore was shipped.

In 1951 J. N. House, of Aguila, acquired the property, and during the following year lessees mined a few thousand tons of mill ore, which was concentrated in the jig mill of the U. S. Manganese Corp. at Aguila. Late in 1952 the property was purchased from J. N. House by the present owners, Fred Seifert and L. W. Smith, of Aguila, who equipped and rehabilitated the mine and resumed production early in 1953. By the first of April 1954, 6,000 to 7,000 tons of ore containing about 18 percent manganese had been shipped to the Wenden stockpile. When visited in April 1954 about 25 tons of ore was being mined daily.

The manganese minerals, pyrolusite and

psilomelane, occurred in a fracture zone trending north and cutting andesite and tuffs. The outcrop of the mineralized zone was exposed for about 800 feet along the strike and ranged from 5 to as much as 50 feet in width. A group of faults trending east and crossing the central part of the outcrop displaced the zone and separated it into six or more offset segments (fig. 6). The individual segments ranged from 30 to 300 feet in length. Some were displaced only a few tens of feet and others as much as 100 feet. Some dipped steeply westward and others eastward.

Nearly all the vein segments had been developed to some extent. The higher grade ore was mined in opencuts and pits and from underground workings extending from several shafts. The deepest mine level at the time of the visit was about 100 feet vertically below the outcrop. The higher grade ore in the northern segment of the deposit had been stoped to various depths for about 300 feet along the strike. The stope ranged from 4 to 12 feet in width and appeared to have reached a maximum depth of some 60 feet. The surface soil had been stripped from an area along the eastern or footwall side of the stope. This work exposed the outcrop of a lower grade zone of mineralization ranging from 30 to 75 feet in width and traceable for about 200 feet along the strike. The zone contained a network of veinlets and narrow seams of manganese oxides impregnating the brecciated wall rocks. Aside from the stripping, no further exploration of this lower grade material had been attempted.

In April 1954 the higher grade ore in the three north segments was being mined from stopes extending above the lower level. The ore was broken in open stopes and hoisted from a centrally located inclined shaft. The walls of the deposit were strong and required only occasional stulls or pillar supports.

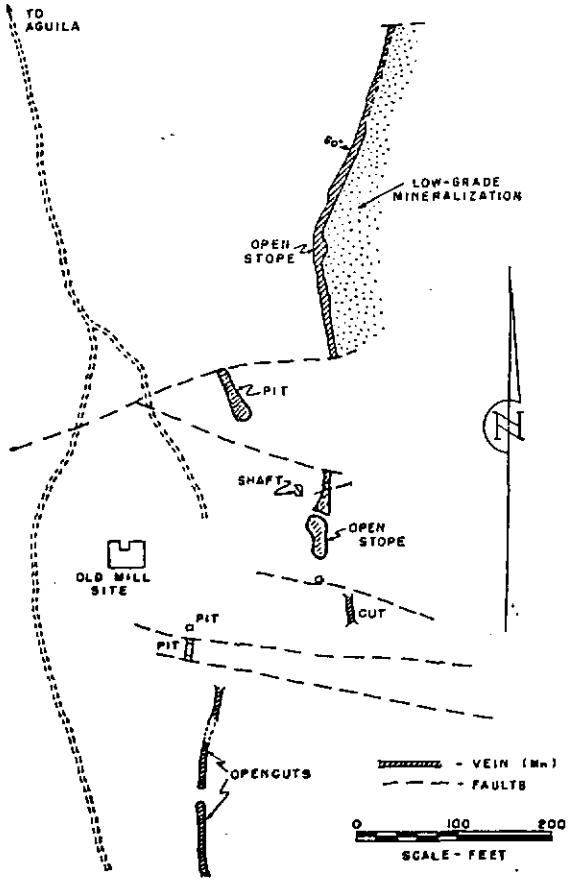


FIGURE 6.—Surface Plan, Black Queen Mine.

BLACK SUE

The Black Sue group of 6 unpatented claims is about 16 miles southwest of Aguila, approximately in unsurveyed sec. 31, T. 5 N., R. 9 W. The property is 1.5 miles south of the Black Queen mine over the same road.

So far as known, the claims were located first in 1950 by J. N. House, of Aguila. When the area was visited in April 1954, L. W. Curry and T. S. Heise, of Wickenburg, Ariz., were operating the property under a lease and option from J. N. House. Operations were started by the lessees late in 1953. By mid-April 1954 about 1,600 tons of mill ore had been produced. Approximately 1,100 tons of this ore was concentrated in the Aguila mill of the Harquahala Milling Co., and the remaining 500 tons was shipped to the Wenden stockpile.

Several manganese deposits occur on the property along a fracture zone in andesite. The zone strikes northwest and dips steeply southwest. The mineralized part of the zone, which furnished the production, was traceable for about 350 feet along the strike and ranged from 20 to 40 feet in width. Other disconnected and rather widely spaced outcrops of manganese mineralization were found on the property along the general trend of the fracture zone. However, the exploratory work on these exposures was too limited to indicate their extent.

The ore from the productive deposit was mined in an opencut or pit about 80 feet long and 35 to 40 feet wide. The cut had reached a maximum depth of about 18 feet below the surface when visited in April 1954. The best ore appeared to be localized along the walls of the fracture zone. This higher grade material, ranging up to 5 feet in width, constituted the ore that was shipped to the Wenden purchasing depot.

The principal manganese minerals were the common oxides, pyrolusite predominating. The gangue consisted of wall-rock inclusions, calcite, and quartz.

The ore was broken by vertical blast holes

drilled along the face of the pit with a jackhammer-type rock drill. The broken ore was loaded into trucks with a gasoline-driven front-end loader. When visited late in April 1954, about 40 tons of ore was being mined daily.

BLACK RAVEN AND CROW GROUPS (PITTSBURGH GROUP)

The Black Raven and Crow properties comprise adjoining groups of unpatented claims about 18 miles southwest of Aguila in sec. 1, T. 4 N., R. 10 W. The properties can be reached over a side road that branches east from the main road about 16 miles southwest of Aguila.

The claims cover the area that was known as the Pittsburgh group during World War I. They were relocated in 1940 and called the Wisconsin group. There are no records showing that any ore was shipped from the property until 1953. The six claims comprising the Black Raven and Crow groups were relocated in 1951 by J. N. House, of Aguila. When visited in April 1954, the Black Raven claims were leased to H. R. Miller and Hans Christoferson, and the Crow group was leased to W. H. Bracken. During 1953 and the early part of 1954 about 500 tons of ore was shipped from the 2 groups to the Wenden stockpile. Most of this ore, containing 20 to 25 percent manganese, was mined from the Black Raven group.

Manganese mineralization occurs on the properties in 10 or more veins and fracture zones cutting the older schistose and granitic rocks. The mineralized fractures range from 1 to 8 feet in width and vary widely in attitude, some striking north and dipping steeply westward and others striking east and dipping moderately southward. Three of the wider veins were exposed for several hundred feet along the strike.

Ore had been mined in scattered opencuts from 4 of the veins on the Black Raven group and from 2 veins on the Crow claims. Several hundred tons of ore containing less than 15 percent manganese was stockpiled on the Black Raven group. The operators intended to have this ore concentrated in a mill being built a few miles to the north by the Thomas Mining & Milling Corp. When visited early in April 1954, 5 men were employed in exploratory work on the Black Raven group, and 2 men were mining and sorting ore on the Crow claims.

The manganese oxides, chiefly pyrolusite and psilomelane, occurred in the fracture zones as rather persistent veinlets up to 6 inches in width and in narrow seams surrounding brecciated fragments of the wall rocks. Calcite was abundant in all the veins.

APACHE AND DULCY CLAIMS (GALLAGHER AND FLYNN GROUPS)

The Apache and Dulcy properties, comprising adjoining groups of two claims each, are held under location by J. N. House, of Aguila. The claims are about 16 miles south of Aguila approximately in unsurveyed sec. 29, T. 5 N., R. 9 W. They are accessible over a side road about 2 miles long that branches southwest from the main graded road 2 miles west of the Black Rock No. 1 mine.

The property, originally known as the Gallagher and Flynn group, was located during the First World War. In 1918 the production totaled approximately 70 tons of sorted ore containing 40 percent manganese. The claims were relocated by J. N. House in 1951. During 1953 lessees shipped about 250 tons of ore, containing about 18 percent manganese, to the Wenden stockpile. In April 1954 the claims were leased to Frank McElrath, of Long Beach, Calif., who was preparing to operate the property.

Ore had been mined from 2 veins about 750 feet apart, striking north, with steep reverse dips. The east vein, which is on the Dulcy No. 2 claim, occurs along a contact between granite and andesite. Ore had been mined in this vein from an opencut about 75 feet long and 30 feet deep. The opening ranged from 2.5 to 4 feet in width and followed the better mineralized footwall portion of the vein. Lower grade mineralization, consisting of narrow seams of manganese oxides surrounding brecciated fragments of andesite, occur along the eastern side of the cut. As exposed in places on the surface, this zone of lower grade mineralization was as much as 30 feet wide. A cover of soil prevented tracing the zone for any appreciable distance along the strike.

The west vein, which is on the Apache claim, occurs in granite and is exposed along the strike for about 400 feet. It ranges from 3 to 4.5 feet in width and dips steeply westward. Ore had been mined along the northern half of the vein from a series of disconnected opencuts and pits that reached depths of 25 feet. This vein furnished the bulk of the ore produced from the property.

Other less prominent outcrops of manganiferous material were found on the claims, but the work on these consisted essentially of discovery pits.

The principal manganese mineral is pyrolusite, with some psilomelane. The gangue is composed largely of wall-rock fragments and calcite.

AMERICAN

The American group comprises four unpatented claims approximately in unsurveyed

sec. 20, T. 5 N., R. 9 W. The property is accessible over a short side road that branches east from the southeast fork of the main road about 15 miles southwest of Aguila.

The claims were located originally in 1939 by J. B. Webb and John Rogers. In 1952 they were acquired by the present owner, Northfleet Knabe, of Aguila. When the district was visited in April 1954, the property was idle, but it recently had been optioned to F. L. Robinson, of Wickenburg, Ariz., who expected to start exploration work in the near future. A relatively small amount of ore was produced from some of the claims, but the tonnage and grade were not known.

Manganese mineralization on the property occurs in three veins or fracture zones trending north and cutting andesite. The fractures are separated by intervals of 200 to 500 feet, dip steeply westward, and range from 2 to 15 feet in width. The west fracture of the series was exposed in a shallow opencut for about 50 feet along the strike. The higher grade material in the cut ranged from 2 to 4 feet in width. The outcrop of the central mineralized fracture, about 200 feet to the east, is traceable for 150 feet and ranges from 10 to 15 feet in width. This deposit had been explored by a discovery pit and several cuts. The east fracture was exposed in a single opencut about 500 feet northeast of the west vein. The cut crossed 6 feet of well-mineralized material. The outcrop of this deposit was covered with soil, so the lateral extent of the mineralization could not be traced for any appreciable distance beyond the opening.

The manganese minerals comprised a mixture of the common oxides occurring as strands and narrow seams surrounding included fragments of the brecciated wall rock.

KNABE NO. 6

The Knabe No. 6 property comprises two unpatented claims approximately in unsurveyed sec. 6, T. 4 N., R. 9 W. The claims adjoin the Crow group and can be reached over a side road about 2 miles long that branches east from the main road 16 miles southwest of Aguila.

The property was located in 1952 by Northfleet Knabe and later leased to F. A. Sitton and J. E. Robinette, of Phoenix, Ariz. During 1953 the lessees mined 500 to 1,000 tons of ore containing 8 to 10 percent manganese. This material was concentrated in the custom mill of the Harquahala Milling Co. in Aguila. The property was inactive when visited in April 1954.

The principal deposit is a northerly trending shear or brecciated zone in granitic rocks containing innumerable veinlets and seams of manganese oxides. The mineralized portion of the zone ranges from 30 to 50 feet in width and is traceable for about 100 feet along the strike. The ore was mined in an opencut or pit about 80 feet long and as much as 50 feet wide. The deepest part of the pit was not more than 25 feet below the outcrop.

Pyrolusite is the dominant manganese mineral. The principal gangue constituents are unreplaced fragments of country rock, calcite, and quartz.

LIONS DEN

The Lions Den property, comprising two unpatented claims, is in sec. 35, T. 5 N., R. 10 W. The property can be reached over a side road about 2 miles long that branches southwest from the west fork of the main road 16 miles southwest of Aguila.

The claims were located in 1952 by Alton Powell and Hal Richardson, of Aguila. In 1953 they were leased and operated by F. A. Sitton, of Phoenix. When the area was visited in April 1954, the property was reported to be under option to the Aguila Mining & Milling Co. Available information indicated that 500 to 600 tons of mill ore was produced from the claims during 1953 and the early part of 1954. Some of this ore was shipped to the Wenden stockpile, but the greater part was concentrated in the Aguila mill of the Harquahala Milling Co. The property was inactive when visited in mid-April 1954.

Manganese mineralization on the claims occurs in brecciated zones trending north in andesitic lava. The mineralized portion of the principal deposit ranges from 10 to 25 feet in width and is exposed for about 100 feet along the strike. Ore had been mined along the southern end of the zone in an opencut and from an inclined shaft. The opencut was 6 to 10 feet wide, about 25 feet long, and 10 feet deep. The shaft, at the north end of the cut, was about 25 feet deep. Both openings followed the footwall of the breccia, where the better mineralization appeared to be localized. About 250 feet northeast of the opencut the soil cover had been stripped from the top of another manganese-bearing breccia. As exposed by the stripping, this zone is mineralized for about 150 feet along the strike and ranges up to 30 feet in width. Apparently no material had been mined from this deposit.

The manganese minerals, consisting of a mixture of the common oxides, occur in irregular masses and narrow seams surrounding the brecciated fragments of country rock. The principal gangue constituents, in addition to the unreplaced framents of wall rock, are calcite and iron oxides.

WEBB CLAIMS

The Webb group comprises three unpatented claims in sec. 25, T. 5 N., R. 10 W. The property is accessible over a short side road that leaves the west fork of the main road about 15 miles southwest of Aguila.

The claims, located originally in 1939 by J. B. Webb, were acquired by the present owner, Northfleet Knabe of Aguila, in 1952. So far as known, no ore has been shipped from the property. However, during the course of considerable exploratory work in 1953 several thousand tons of low-grade manganese ore was mined and stockpiled on the property. The owner expected to have this ore concentrated upon the completion of a mill being built in the vicinity by the Thomas Mining & Milling Co. No work was in progress when the property was visited in April 1954.

Manganese mineralization on the claims occurs in two fracture zones trending west and cutting andesitic lava. The zones are about 75 feet apart and dip steeply southward. The northern fracture is about 20 feet wide and is exposed for 150 feet along the strike. The southern zone ranges from 15 to 20 feet in width and is exposed for about 60 feet along the strike. Both deposits had been explored by opencuts. The cut on the north zone was approximately 100 feet long, 10 to 20 feet wide, and about 12 feet below the surface at its deepest point. The opening on the south deposit was about 60 feet long, 3 to 10 feet deep, and 15 to 20 feet wide.

The manganese oxides, chiefly pyrolusite, occur in the fracture zones as irregular bunches and veinlets and in narrow seams surrounding the brecciated fragments of the country rock. Calcite is abundant in the mineralized portions of the fracture zones.

MOHAVE COUNTY

The principal manganese deposits in Mohave County occur in the southern part of the county north of the Bill Williams River and along the Colorado River south of Topock. A few other isolated occurrences have been found in the central and extreme northwestern parts of the county (fig. 7). The most noteworthy deposits are the manganiferous sediments of the Artillery Mountains region near the southeastern corner of the county. This region is generally recognized as containing one of the largest reserves of low-grade manganese-bearing material in the United States (fig. 8).

Southern Mohave County is a sparsely inhabited semiarid region characterized by broad desert valleys bordered by isolated mountain ranges. The region is accessible from the north by desert roads branching south from United States Highway No. 66 and from the south by improved dirt roads branching north from United States Highways Nos. 60–70 and 89. The deposits in the southeastern part of the county are most readily accessible from both Wenden and Congress, Ariz. Both of these communities are shipping points on the Atchison, Topeka & Santa Fe Railway and are some 40 miles by road from Alamo crossing on the Bill Williams River. This river is the only perennial stream in the region and during flood periods may be impassable for weeks at a time. At such times the area can be reached from Yucca about 60 miles north of the River.

During 1953 two new crossings, known as the Brown and Black Diamond crossings, were built across the river above Alamo. The former is about 3 miles upstream from Alamo, and the latter is approximately one-half mile farther east. The deposits along the eastern side of the Artillery Mountains region are most readily accessible from the new crossings, whereas those in the western part of the area can be reached more readily by crossing the river at Alamo (fig. 9).

The deposits in the southwestern part of the county near the Colorado River are accessible on unimproved desert roads that branch south from United States Highway No. 66 a few miles east of Topock, Ariz.

HISTORY

Though the occurrence of manganese in Mohave County was known much earlier, the deposits were of no economic interest until 1914 after the outbreak of World War I. Many claims were located during this period, and the first ore appears to have been shipped in 1917 [5] from a group of claims near the Colorado River some 35 miles south of Topock.

The first known shipments from the Artillery Mountains were made in 1928, when about 4 carloads of sorted ore containing 41 to 45 percent manganese was shipped from the original Black Warrior group. These claims are said to have been the first locations in the area and originally were held by one of the Rodgers brothers, of Alamo. In 1928 the Black Warrior claims were known as the Graham property. At present they comprise a part of what is commonly called the McGregor deposit.

In 1928 Mack C. Lake examined the deposits in the Artillery Mountains region and, recognizing their importance, interested the Chapin Bros., of Chicago, who formed the Chapin Exploration Co. This company acquired about 1,700 acres of promising ground in the central part of the area and explored some of the outcrops during 1929. The following year D. W

[5] Jones, E. L., Jr., and Ransome, F. L., Deposits of Manganese Ore in Arizona: Geol. Survey Bull. 710 (d), 1920, pp. 93–134.

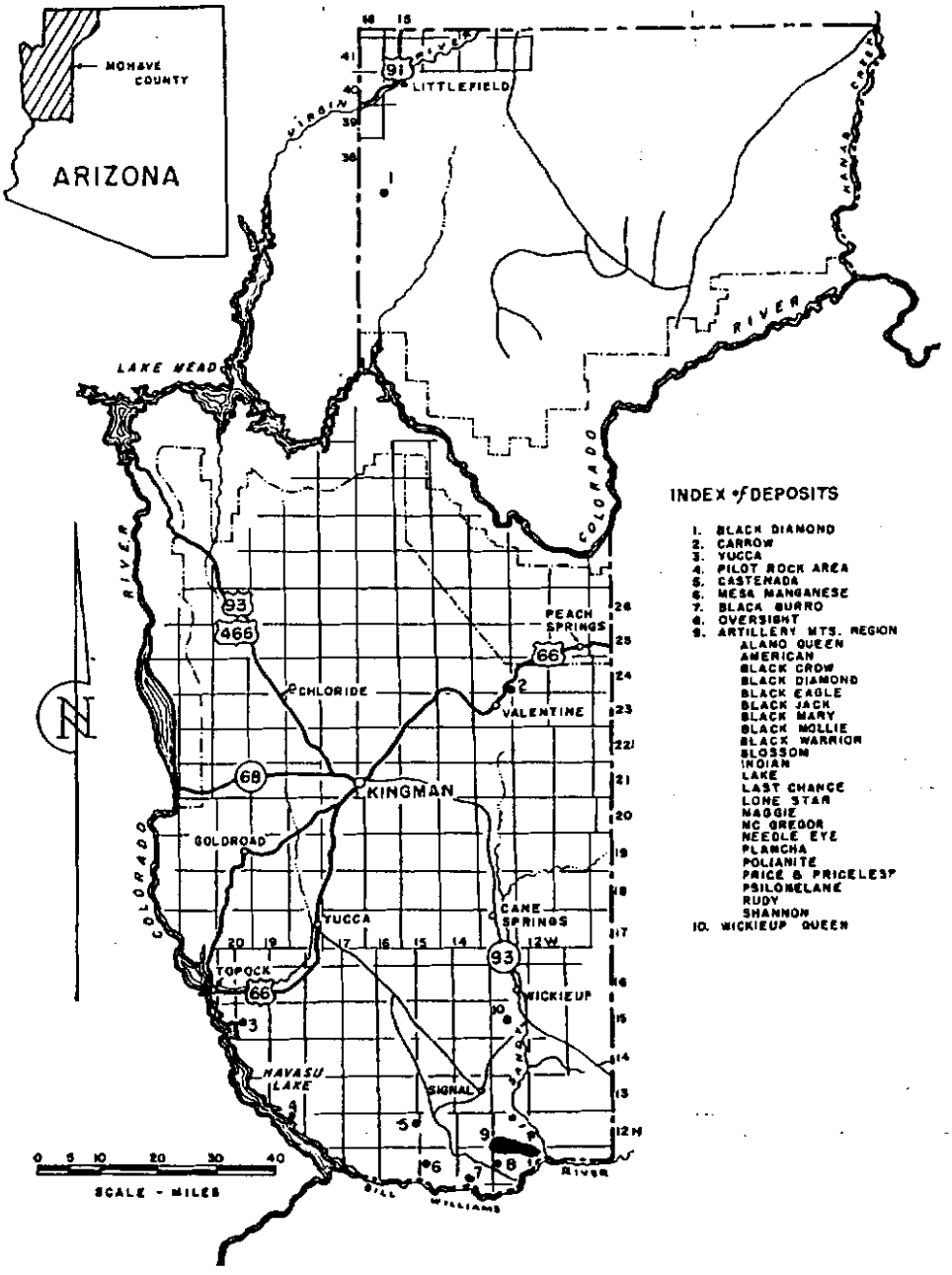


FIGURE 7.—Manganese Deposits of Mohave County.

Woodbridge and associates acquired claims covering the manganiferous beds in Maggie Canyon northwest of the Chapin group. These claims, comprising about 2,000 acres, later became the property of the Arizona Manganese Corp.

In 1936 the M. A. Hanna Co., of Cleveland, Ohio, obtained leases on about 2,500 acres owned by Mack C. Lake, Chapin Exploration Co., and the Arizona Manganese Corp. In June 1937 this company began exploration of these holdings by diamond drilling. The work continued intermittently until April 1940, when 28 widely spaced holes were completed. Two years later the company drilled 40 additional holes.

During 1938 and 1939 a detailed study of the deposits and a geologic map of the Artillery Mountains region [6] was made by S. G. Lasky

[6] Lasky, S. G., and Webber, B. N., Manganese Resources of the Artillery Mountains Region, Mohave County, Ariz.: Geol. Survey Bull. 961, 1949, 86 pp.

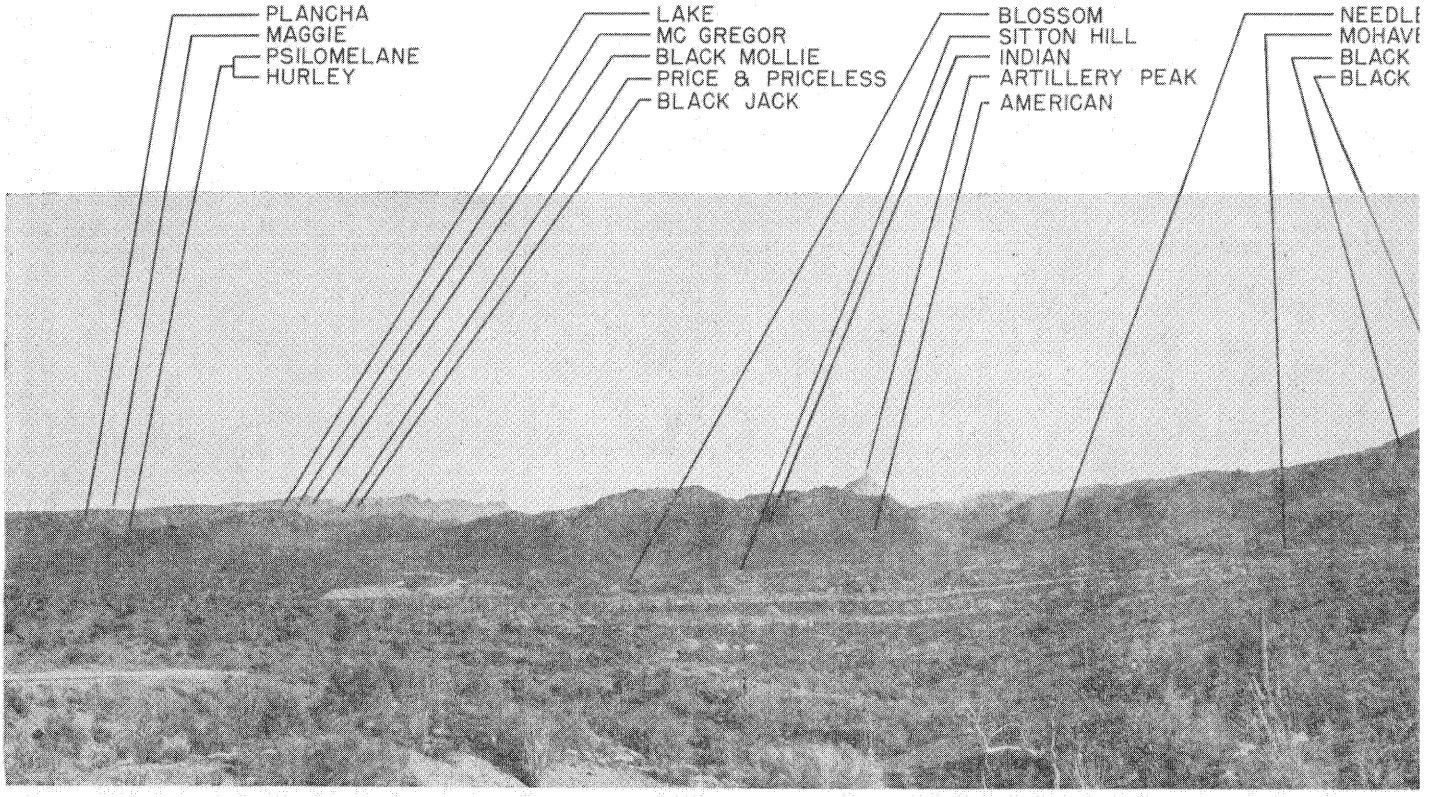


FIGURE 8.—Panoramic View of Artillery Mountains.

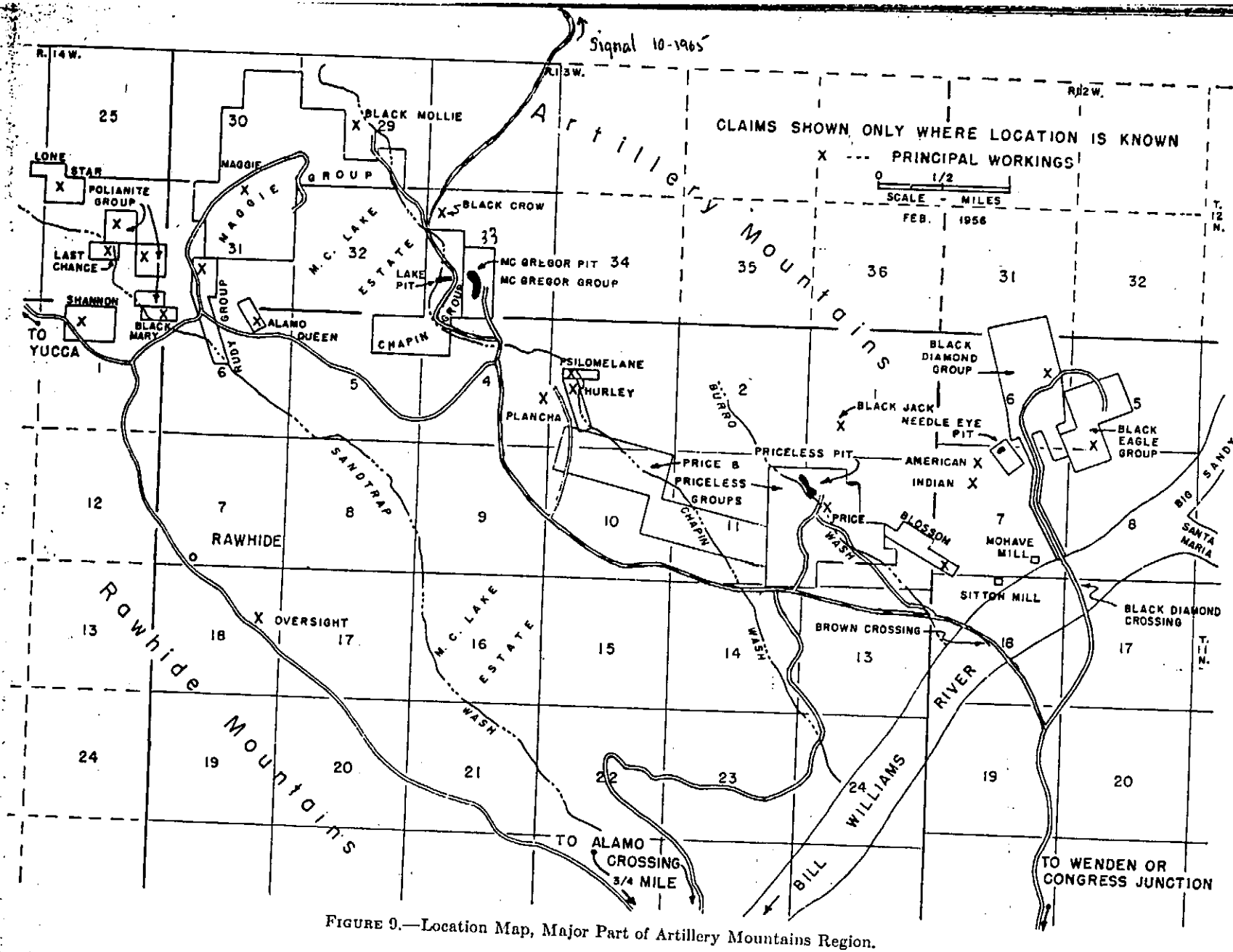


FIGURE 9.—Location Map, Major Part of Artillery Mountains Region.

and R. J. Roberts, of the Federal Geological Survey, in cooperation with B. N. Webber, geologist for the M. A. Hanna Co.

Between November 1940 and June 1941 the Federal Bureau of Mines explored an area covering a part of the Maggie group.[7] The work consisted essentially of surface trenching, the completion of 15 diamond-drill holes, and the extension of an adit driven by the owners of the property. Some experimental stoping was done by the Bureau in the adit workings to test the strength of the ore and the overlying beds and to furnish ore for metallurgical testing in the Bureau's pilot plant at Boulder City, Nev.

Again, in 1949 the Bureau of Mines was authorized to undertake further exploration and underground development of the Maggie deposit. The project work, which was begun in July 1949 and completed in July 1951, consisted essentially of additional diamond drilling and the completion of some 2,100 feet of drifting and crosscutting from 3 adits. The underground work outlined and partly developed a sizable block of ore in the Maggie deposit. About 2,000 tons of ore broken during the course of this work was shipped to the Bureau's pilot plant at Boulder City, Nev., for metallurgical testing.

In 1952, after the opening of the Government purchasing depots in Deming, N. Mex., and Wenden, Ariz., manganese mining was resumed, and most of the more promising deposits in the county eventually were placed in operation. During the next 3 years as many as 31 properties produced ore, and 3 gravity concentrating plants were built along the Bill Williams River a few miles upstream from Alamo crossing. Production reached its peak in 1954. The Wenden depot filled its prescribed allotment of 6 million long dry units of recoverable manganese and closed on May 9, 1955. After the closing of the Wenden depot only a few properties that furnished ore to the mills continued to operate. The concentrates produced in the mills were shipped to the Government purchasing depot in Deming, N. Mex., until that depot reached its quota and closed November 30, 1955.

When the area was visited late in February 1956, two of the larger mills on the Bill Williams River were in operation and were shipping their products under the Government carlot purchasing program.

PRODUCTION

Manganese was first produced in Mohave County during the First World War and was mined intermittently through 1930. Production was resumed in 1940 during the Second World War and continued through 1945. Authentic records of this early production are not complete. Estimates indicate that during the above periods some 5,000 tons of high-grade sorted ore was shipped from the county. Except for a few hundred tons, all of this ore appears to have been mined in the Artillery Mountains from the original Black Warrior claims. The earliest shipments (1928 to 1930) from this property were made in the name of W. H. Graham, and those during 1940 to 1945 were shipped by Norman W. McGregor.

During the cycle of activity between January 1952 and December 31, 1955, the production of Mohave County totaled approximately 79,300 long tons of crude ore, averaging about 18.5 percent manganese, and nearly 61,000 long tons of concentrates, averaging close to 30 percent manganese. All of the crude ore and virtually all of the concentrates were shipped to the Government stockpile in either Wenden, Ariz., or Deming, N. Mex.

In addition to the crude ore shipped direct, estimates by the operators indicate that close to 300,000 tons of ore was mined and milled, from which the 61,000 tons of concentrates was recovered. The ore treated in the mills was mined largely from four deposits in the Artillery Mountains.

GEOLOGY

The manganese deposits in Mohave County occur as stratified or bedded deposits in sedimentary rocks and as veins and in sheared and brecciated zones that cut both igneous and sedimentary rocks. The igneous rocks consist essentially of Precambrian granites and basaltic lavas probably of Tertiary age. The sedimentary host rocks comprise Paleozoic limestones and beds of sandstone, clay, and conglomerate that are considered to be of Tertiary age.

The rocks in the Artillery Mountains region as named and described by Lasky and Webber[8] include a basement of Precambrian granite, gneiss, and schist upon which rest a few exposures of Paleozoic limestone and quartzite. Overlying these older formations are several thousand feet of Tertiary sediments and volcanic rocks, which are capped by younger basalt flows. The Tertiary rocks, in order of age as subdivided by Lasky and Webber, include the Artillery formation, unnamed volcanics, the Chapin Wash formation, the Cobwebb basalt, the Sandtrap conglomerate, and the later basalts that now cap some of the larger mesas.

The Artillery formation consists of closed-basin deposits of reddish sandstone, clay, conglomerate, shale, some limestone and tuff,

[7] Sanford, Robert S., and Stewart, Lincoln A., Artillery Peak Manganese Deposits, Mohave County, Ariz.: Bureau of Mines Rept. of Investigations 4275, 1948, 45 pp.

[8] Work cited in footnote 6.

and a widespread basalt member. In places the Artillery beds attain an estimated thickness of 2,500 feet. The Chapin Wash formation, which contains the principal manganese-bearing beds, is over 1,500 feet thick at its widest point and consists of alluvial-fan and playa deposits composed largely of sandstone, clay, mudstone, and conglomerate. The different beds in the formation range in color from pink through reddish brown to black and in places contain layers of white tuff and limestone. The reddish beds owe their color to iron oxides and the black beds to manganese oxides. A lava flow, known as the Cobwebb basalt, rests upon the Chapin Wash formation. This basalt is up to 250 feet thick and is overlain by the Sandtrap conglomerate, a light- to dark-red rock consisting of sandstone and clay, with abundant pebbles ranging from a quarter of an inch to several inches in diameter, and occasional boulders as much as 6 feet in diameter. After deposition of the Sandtrap conglomerate, basalt flows covered much of the area. Faulting and erosion have since exposed the underlying rocks and the manganiferous outcrops.

Other deposits beyond the Artillery Mountains region in southern Mohave and northern Yuma Counties occur in sandstones and conglomerates similar to those found in the Artillery Mountains.

MANGANESE OCCURRENCES

The known deposits in the Artillery Mountains region of Mohave County occur in an area roughly 8 miles long and some 3 miles wide that lies northwest of the Bill Williams River near the extreme southeastern corner of the county. Most of the major manganiferous outcrops in the area are in the foothills along the southern flank of the Artillery Mountains and across the valley near the northern side of the Rawhide Mountains.

The principal types of deposits in the region are: (1) Bedded or stratified deposits, which occur in parts of the Chapin Wash formation and to a lesser extent in parts of the Artillery and Sandtrap formations, and (2) deposits that occur in veins and in fracture and brecciated zones, which traverse most of the formations in the area, including the older basalts.

The bedded deposits in the Chapin Wash formation occur in 2 principal zones, an upper zone near the top of the formation and a lower zone 750 to 1,000 feet stratigraphically below. The upper zone contains the bulk of the known reserves in the region; the lower zone crops out in places in the valley along the north side of the Rawhide Mountains. Although some low-grade ore has been mined from shallow cuts on some of the outcrops, the zone otherwise remains unexplored, and little or nothing is known concerning its potentiality.

The deposits in the upper zone occur chiefly along the southern flank of the Artillery Mountains, where they have been explored more or less continuously along the strike for over 6 miles. The zone is made up of a succession of manganiferous beds and lenses separated by barren beds. Both the manganese-bearing and the barren beds vary greatly in thickness and in the number of each that may be present within different parts of the zone. In places several relatively thick manganiferous beds may be separated by only a few thin barren beds, and in other places the barren beds may be thicker and more numerous than the mineralized layers. The zone ranges from a few feet to as much as 350 feet in thickness. Diamond drilling indicates an average thickness of about 65 feet in an area of over 1,000 acres. Drill holes have disclosed that the zone extends for at least a mile down the dip.

Five major faults, striking northwest, cross the region. Some of these have vertical displacements of as much as 300 feet. Minor faulting with vertical displacements from a few feet to 30 feet are quite common in many of the exposures.

Some beds are virtually horizontal, and those that are folded or faulted may dip as much as 50°.

The chief manganese minerals in the unaltered bedded deposits are amorphous, wadlike oxides intermixed with the detrital material composing the beds. These original manganese minerals are considered to have been transported and deposited at the same time that the sediments in which they occur were laid down and thus form what are known as syngenetic deposits. Since deposition the beds have been altered, and parts of some have been enriched by the introduction of additional manganese minerals. This secondary or supergene enrichment is believed to have been accomplished by circulating ground waters which leached the original manganese from some areas and redeposited it in others, largely in the form of psilomelane and manganite. This enriched material is called "hard ore" and appears more abundant where the beds are cut by zones of fracturing or faulting.

The bedded deposits exposed in the Artillery and Sandtrap formations in the Artillery Mountains region are comparatively small and of little commercial importance. However, bedded deposits that seem to be in the Artillery formation have yielded appreciable quantities of ore in places across the Bill Williams River in Yuma County and also in Mohave County some distance west of the Artillery Mountains.

The vein and fracture-zone deposits in the

region occur chiefly in the Artillery and Sandtrap formations. The ore in the simple veins occurs in comparatively narrow and short lenticular bodies distributed erratically along steeply dipping fissures that cut the formations. More extensive deposits have been found in zones of shearing, faulting, and brecciation. This type of occurrence may consist largely of a complex network of seams and veinlets filled with manganese oxides, which surround the fragments of the enclosing rocks. Deposits of this nature have been found in the sedimentary beds and in the basalt members of these beds. Where the manganiferous bedded deposits are cut by zones of fracturing or faulting, some of the beds have been enriched.

In contrast to the bedded deposits, the manganese minerals in the veins and fracture zones were introduced after the rocks in which they occur were deposited.

The better ore in the veins and related types is generally found close to the surface. As greater depths are reached, the higher grade ore in the veins generally gives way to lower grade material.

RESERVES

On the basis of the exploratory work completed up to June 1941, Lasky [9] estimated the reserves in the Artillery Mountains region as follows:

As computed from drill-hole data, supplemented by samples collected for the purpose by the Geological Survey and by measurements of areal extent and thickness beyond the limits of the diamond drilling, all interpreted in the light of geologic study, the upper zone (Chapin Wash formation) contains at least 175,000,000 tons averaging 3.5 to 4 percent manganese. It is estimated that of this total 70,000 tons contains 20 percent or more of manganese, 450,000 tons contains 15 percent or more, somewhat over 2,000,000 tons contains 10 percent or more, and 15,000,000 to 20,000,000 tons contains 5 percent or more. About 15,000,000 tons is hard (supergene) ore averaging 6.5 percent manganese, about 100,000,000 tons is manganiferous sandstone averaging about 3.5 percent, and about 60,000,000 tons is manganiferous clay averaging about 3.5 or 4 percent.

Further exploration of known ore bodies may increase these estimates, and additional ore bodies may be present in the many square miles as yet unexplored. It is probably safe to say that the area contains an assured minimum of 200,000,000 tons averaging 3 to 4 percent manganese, of which about 20,000,000 tons contains 5 percent or more manganese and 2,000,000 to 3,000,000 tons contains 10 percent or more. To what extent these deposits may become a source of manganese is a metallurgical and economic problem.

Since these estimates were made in June 1941, approximately 372,000 tons of ore was mined up to January 1956 from the Artillery Mountains area. Of this amount, some 77,000 tons containing 15 percent or more manganese was shipped direct to the Wenden stockpile, and the balance containing less than 15 percent was concentrated in local mills.

Reserves in the rest of Mohave County containing 15 percent or more manganese as indicated from present exposures are estimated to be about 20,000 tons.

Large outcrops of low-grade manganese-bearing sedimentary rocks have been found within a radius of about 20 miles west and northwest of the Artillery Mountains. These deposits are largely unexplored, and their average grade and full extent remain to be determined.

ARTILLERY MOUNTAINS REGION

MOHAVE MINING & MILLING CO.

The Mohave Mining & Milling Co. operates a 600-ton gravity concentrating plant in Mohave County and a 1,000-ton combination heavy-media-flotation mill and a sintering plant in Yavapai County. A general office is maintained at Wickenburg. H. F. Lynn is president, W. R. Easley is general manager, and A. B. Campbell is secretary and treasurer.

During 1954 and 1955 the company conducted mining operations on the Priceless and Price groups in Mohave County and on mines in Maricopa and Yavapai Counties.

When operations were begun, the ore was concentrated in a log washer on the north bank of the Bill Williams River. Erection of a 600-ton concentrating plant on the same site was completed before the end of the year (fig. 10). The plant includes tables, jigs, and heavy-media separation; the flowsheet is shown in figure 11.

Since January 1, 1956, the company has ceased mining operations and is engaged exclusively in beneficiation of manganese ore on a custom basis.

PRICELESS AND PRICE GROUPS

The Priceless and Price groups, comprising 42 unpatented claims, were located by the Arizona Manganese Corp. in 1937 and amended in 1942. The Corporation leased 19 of these claims to Charles Hart and H. F. Lynn. Later, G. S. Borden became associated in this lease, which soon thereafter was subleased to Mohave Mining & Milling Co. The latter company operated the Priceless and Price pits during 1954 and 1955.

In January 1956 the company discontinued mining operations, which now are conducted by other operators.

The combined production of the Priceless and Price pits for the 3 years 1953 through 1955 has been approximately 51,000 long tons of concentrates averaging 29 percent manganese. It is estimated that about 170,000 tons of raw ore

[9] Work cited in footnote 8 (p. 26).

FIGURE 10.—Concentrating Plant, Mohave Mining & Milling Co.

has been mined from the Priceless and approximately 5,000 tons from the Price.

Early in 1956 the monthly milling rate was approximately 10,000 tons of ore.

Priceless Pit

The Priceless pit covers part of 4 claims largely in the NW¼sec. 12, T. 11 N., R. 13 W., in Burro Wash about 1½ miles northwest of the Brown crossing on the Bill Williams River.

Virtually no exploration work was done on the Priceless deposit until late in 1954, when the Mohave Mining & Milling Co. began stripping the deposit after a few test drill holes indicated that there was an ore bed underlying the alluvium overburden.

As the pit was deepened, it became necessary to divert the stream bed of the normally dry Burro Wash into an adjacent tributary draw to avoid flooding the workings during wet seasons.

In February 1956 the mined portion of the

The deposit is in the upper manganiferous zone of the Chapin Wash formation. Numerous fractures have shattered the beds in a belt extending northwest. Supergene hard manganese oxides, mainly psilomelane and some manganite, have been deposited along these fractures. The limit of this better mineralization appears to have been reached in places along the northeast edge of the pit. However, the width of the ore body to the west has not been determined, nor has the depth of commercial mineralization been established.

It was reported that a fractured remnant of the Cobwebb basalt overlying the Chapin Wash formation in the southeast corner of the pit was mineralized and was mined in the initial phase of the work. Elsewhere in the pit area erosion has removed this basalt member.

Mining Methods

The overburden and waste are stripped from

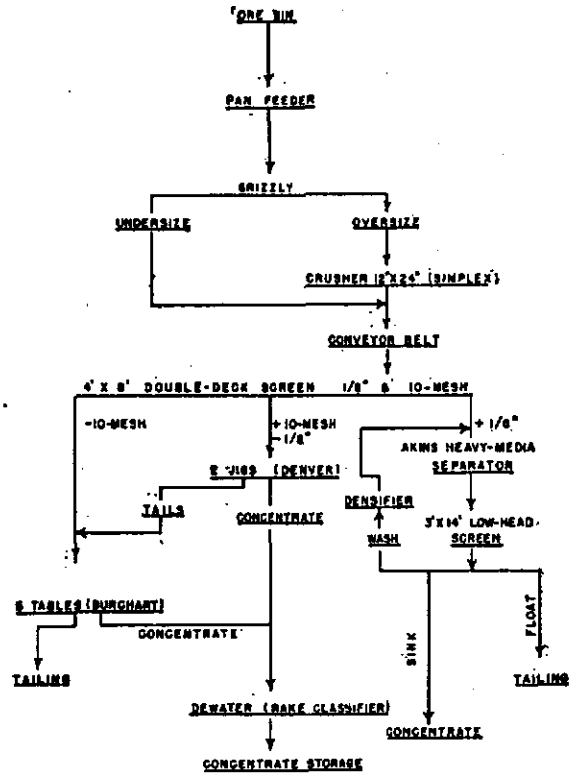


FIGURE 11.—Mill Flowsheet, Mohave Mining & Milling Co.

Blast holes approximately 2½ inches in diameter are drilled with detachable bits set with tungsten-carbide inserts on 1¼-inch drill steel in lengths up to 24 feet. Compressed air is furnished by diesel-driven portable compressors. Vertical holes spaced about 6 feet apart are drilled from the top of the benches, which usually are 25 to 30 feet high. Horizontal holes are used in rounds drilled from the bottom of the benches. The ore drills and breaks readily. Holes are loaded with cartridges of 40 percent gelatin powder and detonated with delay-action (millisecond) electric blasting caps.

A front-end loader fills 15-ton trucks for transportation to the mill.

Price Workings

The Price workings are in the SW¼NW¼ sec. 12, T. 11 N., R. 13 W., on Burro Wash, about 600 feet southeast of the Priceless pit.

Before 1942 the Arizona Manganese Corp. had explored the deposit by an adit and branch drifts, a combined length of 250 feet. In 1953 and 1954 Al Stovall, working under a lease, produced from the area several hundred tons of log-washed ore. This ore was mined from a series of five large, closely spaced adits driven into the outcrop on the east side of Burro Wash, which here is a steep-walled canyon about 50 feet deep.

Later in 1954 the Mohave Mining & Milling Co. took over the property, stripped the overburden, and in 1955 worked the deposit as an open pit. In December 1955 the pit was approximately 90 feet long and 50 feet wide; the maximum height of the face was 30 feet. The floor of the workings is just above the creek bed, and the stub ends of the original adits are exposed in the face of the pit.

Manganese mineralization occurs in the upper part of the Chapin Wash formation. The top of the ore bed is an undulating erosion surface covered with recent gravel. A thickness of about 30 feet of this gravel has been stripped for about 25 feet in advance of the present pit face.

The ore, in general, is soft and friable; the harder but relatively fine-grained manganese oxides occur along the fracture and joint planes. The manganese content appears to decrease along the outcrop south of the pit area.

Stovall, while operating the deposit, passed the ore through a log washer to bring it up to salable grade, but the Mohave Co. beneficiates the ore in its gravity concentrating plant on the Bill Williams River.

Approximately 200 feet east of the face of the pit and 60 feet above, cuttings from a 20-foot wagon-drill hole showed fair manganese mineralization. In February 1956 the operator was preparing to strip this area. About 200 feet farther east an opencut 125 feet long and 15 feet high has been excavated on the northeast side of a small hill; the cut shows stringers of manganese oxides in fine-grained sandstone dipping 45° NW.

WORLD MANGANESE CORP. (SUCCESSOR TO F. A. SITTON)

About December 1955 the World Manganese Corp., of California, acquired an option to purchase all the Mohave County holdings of F. A. Sitton, including the McGregor, Alamo Queen, Black Diamond, Black Eagle, and Blossom properties, the heavy-media and log-washing plants on the Bill Williams River, and the lease on the Needle Eye claims. The corporation also had obtained leases from the Arizona Manganese Corp. covering the Shannon and Lone Star groups. World Manganese also obtained an option from Al Stovall on the Spring mine in northern Yuma County.

The enterprise is operated under the direction of Macafee & Co., consulting engineers, of Los Angeles, Calif. O. L. Jaggers is president of the corporation, and Bruce McDonell, of Macafee & Co., is resident engineer.

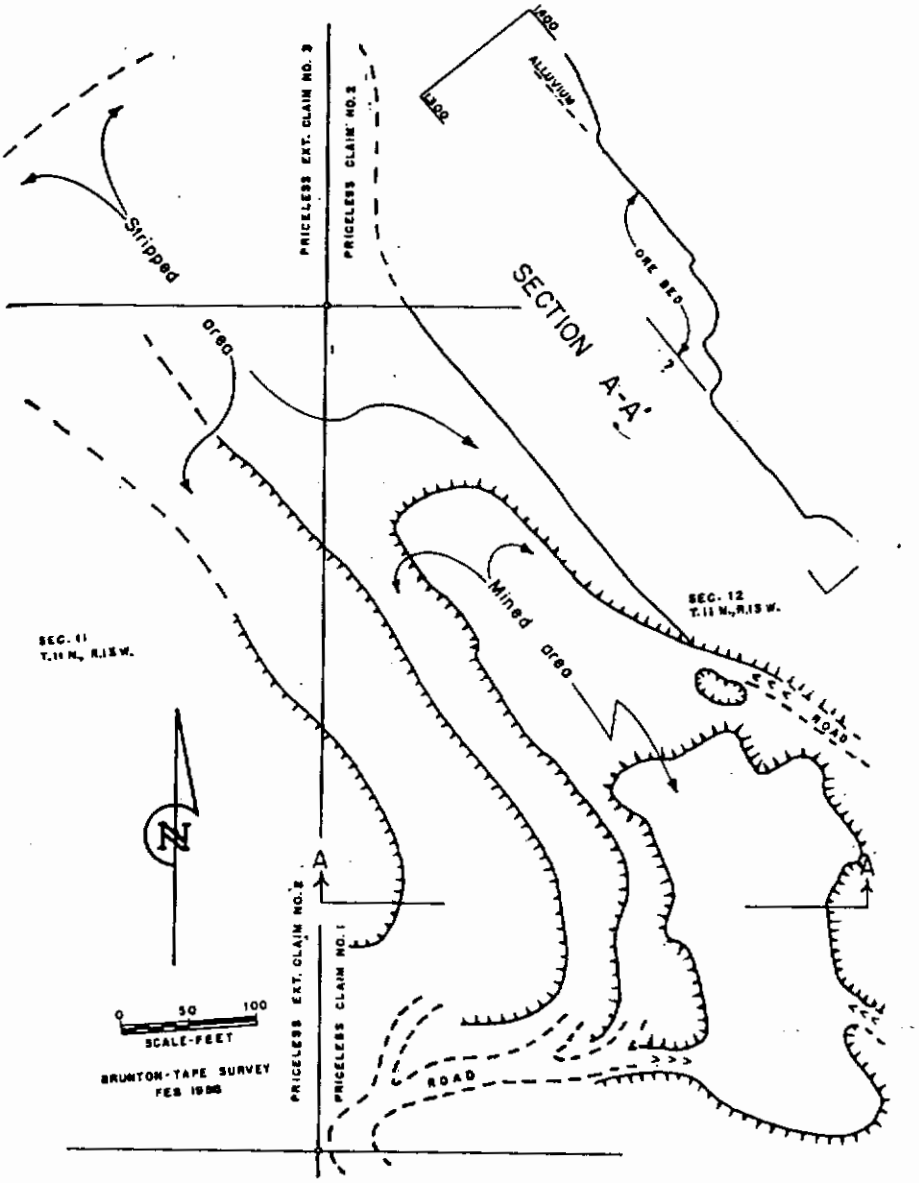


FIGURE 12.—Plan and Section, Priceless Pit.

In February 1956 the Alamo Queen and Needle Eye pits were producing ore, and preparations were being made to convert one of the Black Diamond underground workings into an open-pit operation

McGregor

The McGregor property, also known as the Black Warrior, Graham, and Big Jim, is in the W½ sec. 33, T. 12 N., R. 13 W., and can be reached over a mile of road that branches north from the Brown crossing road approximately 5 miles northwest of the Bill Williams River.

The original claims, the Black Warrior Nos. 1 and 2, were located in the early 1900's by one of the Rodgers brothers, of Alamo. During the First World War they were acquired by W. J. Graham and associates, who prospected parts of the deposit but did not ship any ore. Some ore was produced in 1928, and a year later the Chapin Exploration Co. obtained an option on the claims, which were incorporated with their other holdings and surveyed for patent. Later the Black Warrior group was returned to the former owners. In 1939 Norman W. McGregor acquired a part of the group and operated intermittently until late in 1945. In 1952 F. A. Sitton, of Phoenix, Ariz., purchased the McGregor holdings and acquired leases on some of the adjoining Warrior claims.

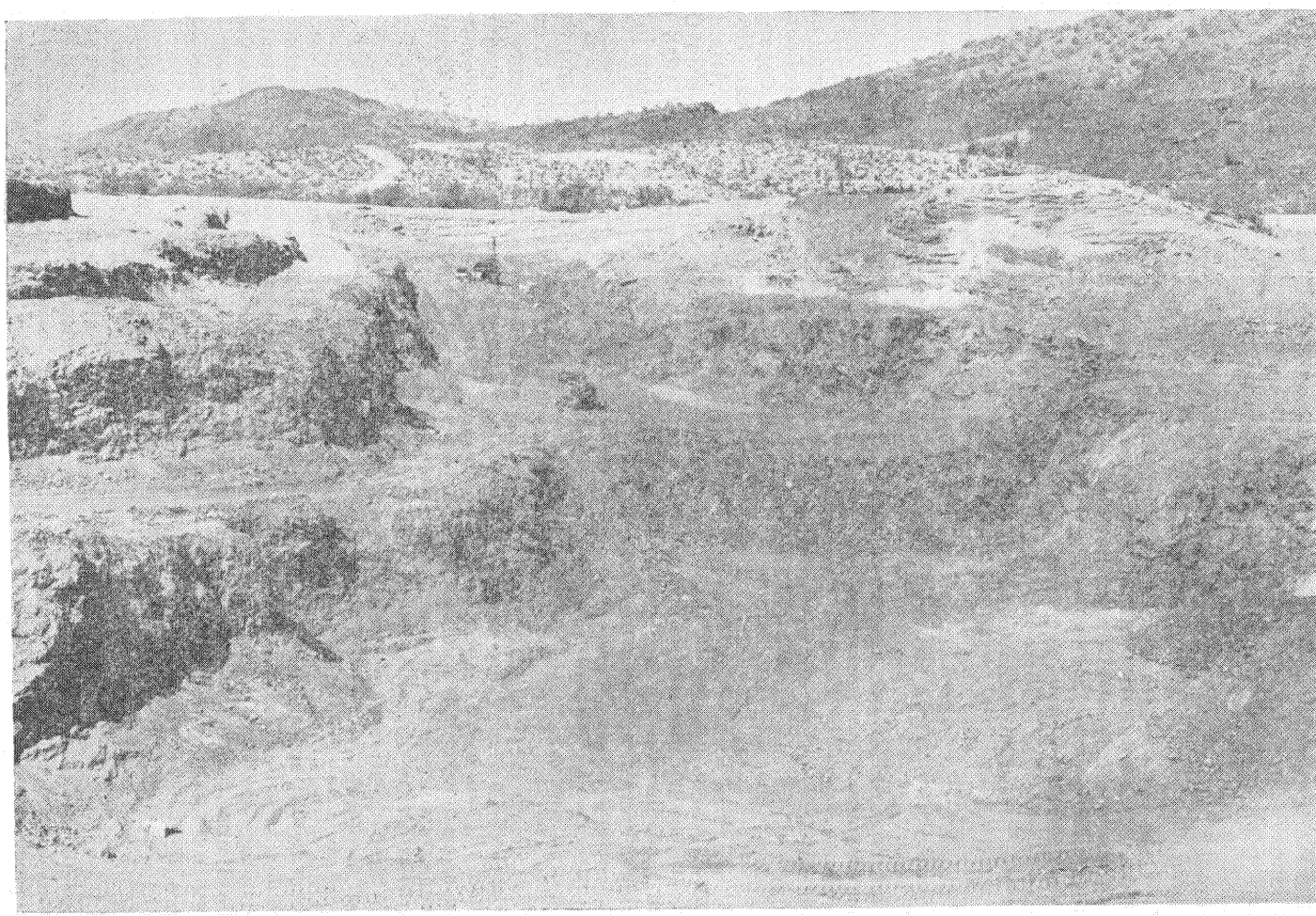


FIGURE 13.—View of Priceless Pit.

The following year Al Stovall, of Phoenix, obtained a lease from Sitton and built a log-washing plant for treating the ore on the Bill Williams River near Brown crossing. Stovall operated the property until early in 1955, when Sitton took it over and continued to mine and mill the ore until shortly before the closing of the Deming purchasing depot in November 1955. A short time later Sitton transferred his interest to the World Manganese Corp.

The first known shipments of ore from the property were made in 1928; shipments were again resumed in 1940 and continued intermittently through 1945. Authentic records of this early production are incomplete. Estimates indicate that perhaps as much as 5,000 tons of sorted high-grade ore was shipped before 1946. Production from 1953 through 1955 amounted to approximately 9,350 long tons of log-washed concentrates, which averaged 33.8 percent manganese. Over 80 percent of these concentrates was shipped to the Government purchasing depot in Wenden, Ariz., and the balance to the depot in Deming, N. Mex. The property was idle when the district was visited in February 1956.

The deposit is in the upper manganiferous zone of the Chapin Wash formation, which crops out in the area along a broad belt several thousand feet long. In places on the property the maximum exposed thickness of the manganiferous zone is some 90 feet. The beds in the zone dip gently southwest and in part, at least, rest upon the older granitic rocks. A high hill west of the pit workings is capped by a remnant of the Cobwebb basalt.

The ore mined from the deposit occurred in parts of the manganiferous zone, where the original bedded material evidently had been enriched along a series of minor parallel faults lying adjacent to a major zone of faulting known as the Common Corner Fault. Near the north end of the pit workings 5 of the minor faults are exposed in a zone about 250 feet wide trending southeast. The fault fractures dip 60° to 70° SW. and displace the beds downward in that direction in a series of steps. The vertical displacement on the individual fractures ranges from 6 to 20 feet (fig. 14).

The enriched material, largely hard psilomelane, occurs along the fault fractures in veinlike deposits and in the segments of a lower bed lying between the faults. The hard ore in each ranges from 2 to 6 feet in width.

The ore produced before 1953 was selectively mined in opencuts and adits driven along the higher grade portions of the steeply dipping mineralized fractures. The ore produced later was mined along the strike in an arc-shaped open pit about 1,600 feet long, up to 250 feet wide, and in places as much as 90 feet below the surface. To reach some of the hard ore it was necessary to strip as much as 90 feet of the overlying low-grade manganiferous sediments. Heavy earth-moving equipment, including bulldozers, rippers, and carryall scrapers, were used in both stripping and mining the ore. The overburden and the ore were soft enough that they could be broken sufficiently by rippers to permit loading with carryalls. F. A. Sitton estimated that some 70,000 tons of ore had been mined in this manner and concentrated in log washers.

Needle Eye

The Needle Eye group of two unpatented claims is near the eastern end of the Artillery Mountains district in the north central portion of sec. 7, T. 11 N., R. 12 W. The property is accessible over a road about a mile long that runs north from the Black Diamond crossing.

The claims were located in 1940 by the present owner, R. S. Rodgers, of Alamo. Early in 1954 they were leased to J. E. Robinette, P. T. Evans, and D. C. Evans. Later that year the lease was acquired by F. A. Sitton and in December 1955 was transferred to the World Manganese Corp. Production from the property at the end of 1955 totaled 476 long tons of sorted ore averaging 21 percent manganese and approximately 711 long tons of concentrates containing 31 to 40.2 percent manganese. The crude ore was shipped to the Government purchasing depot in Wenden, Ariz. Most of the concentrates were produced in the Sitton mill during the latter part of 1955 and were shipped to the purchasing depot in Deming, N. Mex.

The World Manganese Corp. was operating the property in February 1956 and was mining and milling several hundred tons of ore daily.

Manganese mineralization occurs in a complex pattern of fractures and irregular bunches along a steeply dipping shear zone cutting both the sandy beds of the Artillery formation and a basalt member of that formation. The zone crops out on a steep hillside and is exposed for approximately 250 feet northwest along its strike and over a width of as much as 150 feet. The manganese minerals, largely hard psilomelane and manganite, occur in fractures ranging from mere seams to veinlets several inches in width. In some parts of the zone the mineralized fractures are closely spaced and form bands and sporadic masses of ore several feet wide and tens of feet long.

The deposit was mined in 2 benches from an irregular open pit some 200 feet long, 150 feet wide, and as much as 60 feet deep. The mineralization in the upper 25-foot bench occurs in basalt, which appeared to dip gently southwest. The lower bench for the most part

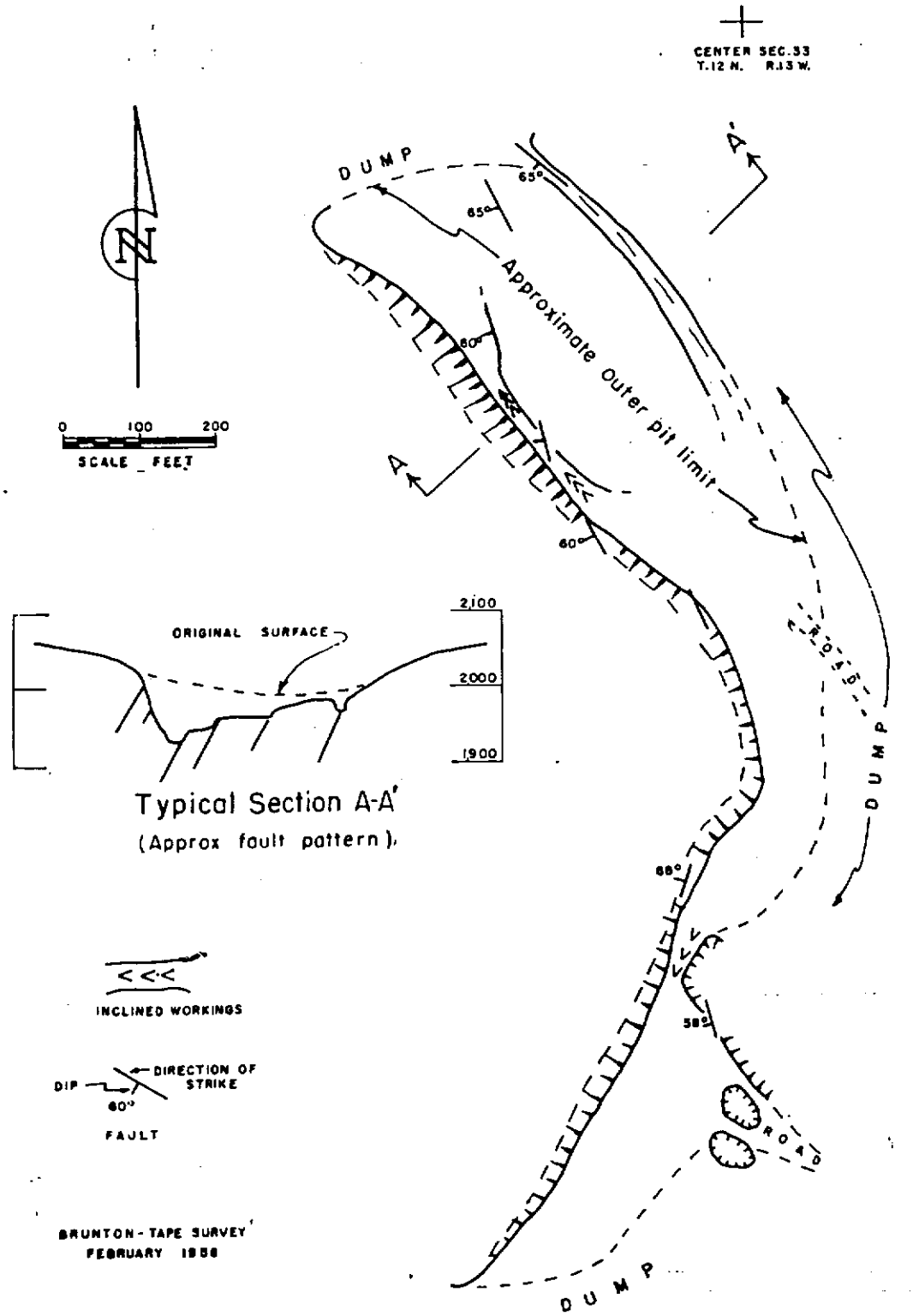


FIGURE 14.—Plan and Section, McGregor Pit.

was in the sandy sedimentary beds underlying the basalt.

Blast holes were drilled with a wagon drill, using 1½-inch round steel with tungsten-carbide bits. Compressed air was supplied by a portable compressor. A diesel-powered front-end loader was used for loading the broken ore into trucks for transportation to the mill.

Alamo Queen (Manganosite)

The Alamo Queen deposit is on an unpatented claim known as the Manganosite in the NE¼ sec. 6, T. 11 N., R. 13 W. The mine workings are a few hundred yards north of the Brown crossing about 7 miles northwest of the Bill Williams River.

The claim was located in 1953 by E. W. Tate, of Yucca, Ariz., and later purchased by F. A. Sitton, of Phoenix, Ariz. The latter began operations in 1955 and after the completion of his heavy-media plant in September of that year mined and milled several thousand tons of ore from the deposit. The resulting concentrates, 3 or 4 carloads, were shipped in part to the Government purchasing depot in Deming, N. Mex., and in part under the carlot purchasing program after the Deming depot was closed. Late in December 1955 the property and other holdings of F. A. Sitton were acquired by the World Manganese Corp. When the area was visited in February 1956, this corporation was mining and milling several hundred tons daily from the property.

The deposit consists of a network of seams and small podlike masses of manganese oxides distributed erratically in an irregular zone of shattered basalt. The basalt is a light-colored vesicular rock apparently occurring as a member of the Sandtrap conglomerate. The zone trends northwest through relatively flat valley terrain lying along the base of the southwestern side of a lava-capped plateau, known as Manganese Mesa. The mineralized area, as exposed at the time of the visit, is about 1,000 feet long and as much as 250 feet wide. The manganese-bearing fractures range from a fraction of an inch to several inches in width, and the podlike masses occasionally are several feet in diameter.

The manganese minerals, chiefly hard psilomelane and manganite, are readily freed by crushing from the enclosing basalt, and for that reason the ore is amenable to simple methods of gravity concentration.

The ore was mined in open pits, the largest of which is approximately 750 feet long, 150 feet wide, and as much as 30 feet deep. It was broken in benches of various heights and loaded into trucks for transportation to the mill by a diesel-powered front-end loader. Holes were drilled with a self-propelled wagon drill supplied with 500 c. f. m. of air by a portable compressor. The blast holes were about 2 inches in diameter and were loaded with cartridges of 40 percent gelatin and detonated by delay-action electric blasting caps. Much of the deposit originally was covered with several feet of detrital overburden. This was removed in advance of the pit openings by bulldozers and carryall scrapers.

Black Diamond Group

The Black Diamond group comprises 22 contiguous, unpatented claims in sec. 6, T. 11 N., R. 12 W., with a slight overlap into the adjoining section to the north and south. It is accessible by a steep 2½-mile dirt road north from the Black Diamond crossing on the Bill Williams River.

These claims originally were located in 1941 by George and Joe Lewis; the locations were amended in 1952 by Claud Neal. Later Neal and C. C. (Pat) Patterson formed a partnership, exploited some of the more promising veins, and produced about 8,600 tons of crude ore averaging 19.3 percent manganese. F. A. Sitton purchased the claims in 1955 and produced approximately 600 tons of crude ore of similar grade. All this ore was shipped to the Wenden depot. During the remainder of his occupancy in 1955, after the Wenden depot was closed, Sitton continued to produce ore, which was concentrated in the heavy-media plant on the river. About December 1955 World Manganese Corp. assumed control and soon thereafter temporarily suspended operations.

Black Diamond Workings.—Manganese mineralization has been localized in more or less parallel fractures or veins within a fissure zone trending northwest and cutting the Artillery formation. Various workings and prospect pits have exposed mineralization along the zone for approximately half a mile.

The principal operation has been the mine that was opened and exploited by Patterson and Neal. An 80-foot entry crosscuts the zone and exposes numerous small fractures containing minor mineralization, a N. 35° W. vein about 2 feet wide, and the footwall vein 5 to 8 feet wide. This latter vein dips 60° to 65° NE. It has been opened by an adit level for 85 feet to the south and about 250 feet to the northwest, and much of this explored length has been stoped to the surface (fig. 15).

A 70-foot winze was sunk down the dip of the footwall vein from the adit level. Near the bottom of the winze a level was driven 60 feet southeast and 100 feet northwest. Stopes on each side of the winze extended to the adit level. A 70-foot crosscut, driven east from this level, intersects nearby mineralized, parallel

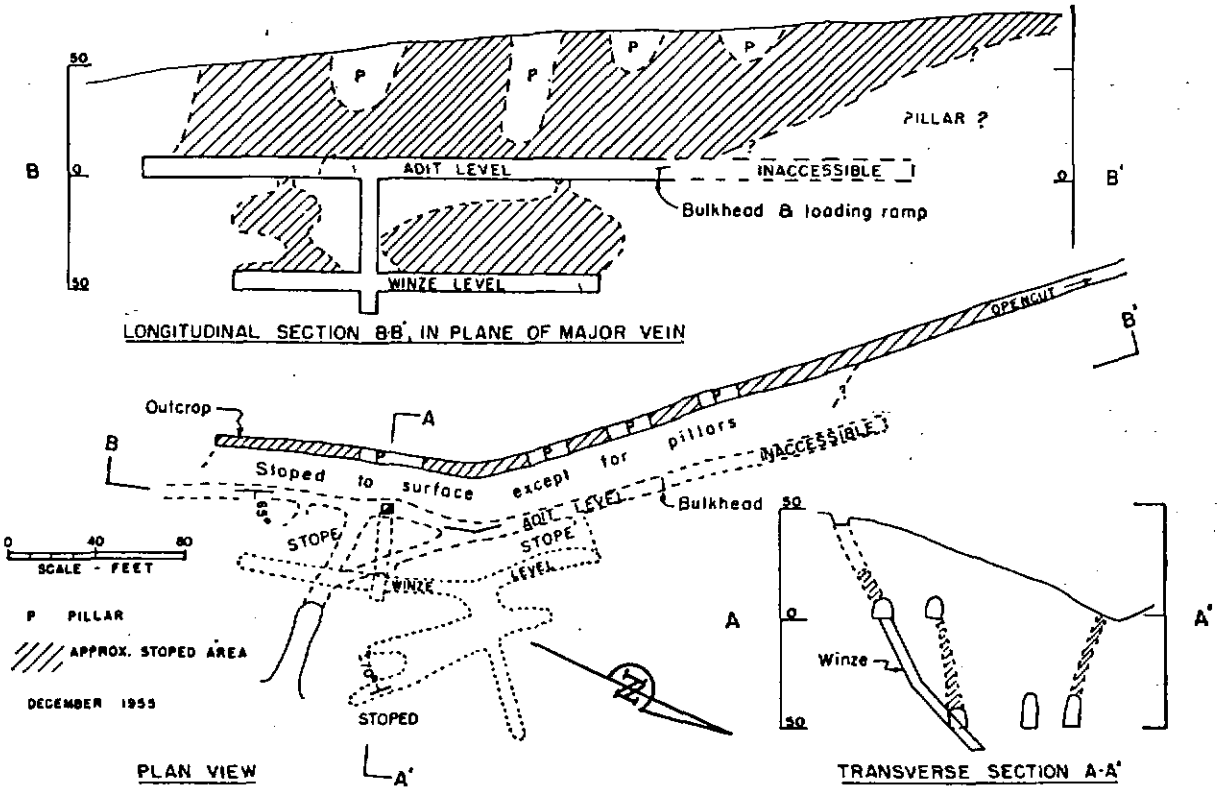


FIGURE 15.—Plan and Section, Major Black Diamond Workings.

fissures. The east vein, dipping southwest, appears to be the northeast side of the mineralized zone, as the last 40 feet of the crosscut penetrated barren sediments. A small stope that is now inaccessible, extends from the southeast end of the lower workings to the surface.

After Sitton took over the operation, work was confined to production from the vein above the adit level at the north end of the mine. A loading ramp was constructed on that level 150 feet within the mine. The ore, broken in the advancing open stope, was scraped down to the ramp and into mine cars. The vein also was opened by a continuous cut to a depth of 10 to 15 feet northwest to the brow of the hill. The end of the cut is approximately 400 feet beyond the end of the mine workings.

The ore consists of hard manganese oxides in stringers and as irregular nodules surround the conglomerate pebbles. The chief gangue mineral is calcite associated with small amounts of quartz.

Soon after acquiring this property, the World Manganese Corp. temporarily suspended work in this area and when visited in February 1956 was formulating plans to mine the entire width of the fissure zone in an open-pit operation.

An extension of one of the veins that traverse the developed area is exposed in the side of a wash some 400 feet southeast of and about 30 feet below the mine entry. A 20-foot adit exposes 3 to 4 feet of fairly high-grade manganese ore. This vein strikes N. 20° W., dips steeply east, and appears to widen with depth.

An 8-foot vein is exposed about 200 feet southwest of this adit and a little higher on the hillside. It is composed of vertical alternating bands of manganiferous material and white calcite. An adit was driven N. 18° W. on this vein; at 45 feet the vein splits, one part swinging north. From this point to the face the mineralization decreases. With the present milling facilities, the manganese content of this vein appears to be too low grade to mine.

Approximately 2,000 feet southeast of the major underground workings, a productive opencut has been developed in a vein associated with the same fissure-zone system. The workings are accessible by half a mile of steep, narrow, truck trail that branches right from the road to the principal workings 1.5 miles north of the Black Diamond crossing.

The vein crops out on the west side of a steep-walled canyon trending north. As the strike is N. 17° W., the vein diverges only slightly from the course of the canyon. The maximum depth of an opencut approximately 150 feet long is nearly 50 feet; the floor of the cut is about 60 feet above the road. The cut occupies the full

width of the 6- to 8-foot vein, in which the best mineralization occurs in an 18- to 24-inch band against the smooth conglomerate wall, which dips 70° NE. The manganese content decreases gradually toward the hanging wall.

A 60-foot raise in the vein was driven from the face of a short adit at road level to the opencut above. The broken ore was drawn from the opencut into the raise by a slusher hoist and scraper and piled up on the floor of the stub adit. A diesel-powered front-end loader filled the trucks for transportation to the mill. As the raise was full of ore, the authors were unable to inspect the vein at the adit level, but the mineralization reportedly was similar to that in the cut above.

The manganese minerals consisted entirely of hard oxides, psilomelane and manganite, occurring as nodules, fissure fillings, and rims around the breccia fragments, associated mainly with calcite.

About 1,500 feet northwest of this occurrence a 170-foot adit follows a vertical vein trending northwest into the hillside. A 40-foot vertical raise about 80 feet from the portal connects with a shallow opencut on the surface. The opencut exposes a mineralized lens approximately 50 feet long and 2 to 4 feet wide. In the adit the mineralization along the vein is confined to stringers and small irregular masses seldom exceeding 6 inches in width. The chief manganese minerals are pyrolusite and psilomelane. The gangue is composed of calcite and pebbles and boulders of the conglomerate beds through which the vein passes.

Black Eagle Group

The Black Eagle group of 12 contiguous unpatented claims adjoins the Black Diamond group on the east and is mainly in the SW¼ sec. 5, T. 11 N., R. 12 W., along the top of the high bluffs overlooking the Bill Williams and the Big Sandy Rivers. The property is about 3 road miles north of the river and can be reached on the same steep winding road that passes through the Black Diamond property.

The claims were located in 1940 by George and Joe Lewis. In 1950 the locations were amended by George Lewis, of Wenden, and Claude Neal, of Valentine, Ariz. During 1953 and 1954 Lewis and Neal shipped about 356 long tons of sorted ore containing 28 percent manganese to the Government purchasing depot in Wenden, Ariz. In 1955 F. A. Sitton acquired the property but later that year transferred his interest to the World Manganese Corp. Some ore was mined by Sitton and treated in his concentrating plant. When the area was visited late in February 1956, operations had been suspended temporarily.

Manganese mineralization occurs in several widely spaced veins and fracture zones that cut the sedimentary beds of the Artillery formation. These occurrences are of the same type as those found to the west on the Black Diamond claims. Five or more veins are exposed on the Black Eagle group in an area roughly 1,000 feet wide and 2,000 feet long. The mineralized fractures strike northward and for the most part dip either vertically or very steeply west. Most of the ore was mined from two veins near the east side of the property. The higher grade ore in the south vein had been mined in opencuts and from an adit for about 200 feet along the strike. Judged by the width of the work, the ore ranged from several inches to 3 feet in width. The south end of the adit reaches a depth of approximately 40 feet below the outcrop. In places open stopes extend from the adit level to the surface.

The other principal underground workings are some 800 feet to the northwest and consist of a drift extending about 100 feet northwest of a crosscut adit of similar length extending northeast. The drift follows the hanging-wall side of a fracture zone containing lenses of ore ranging from a few inches to 3 feet in width and up to 20 feet in length. One of these lenses had been stoped upward for about 30 feet to the surface.

Several hundred feet to the southwest other manganiferous lenses are exposed in several places by pits and shallow opencuts. According to George Lewis, several tens of tons of ore containing over 40 percent manganese was mined from one of these shallow openings.

On the west side of the property a wide, vertical fracture zone containing manganese mineralization is exposed on the hillside about 2,000 feet east of the principal workings of the Black Diamond group. The course of the fracture zone is outlined by a shallow, dry wash dipping south.

Late in 1955 F. A. Sitton developed an opencut on this deposit. Where opened at road level, the zone is 20 to 25 feet wide, strikes N. 15° E., and has been mined to a maximum depth of 20 feet for about 100 feet up the hillside. The vein material is manganiferous calcite containing small nodules and irregular inclusions of hard manganese oxides and narrow stringers of white calcite.

The broken ore was drawn to road level by a gasoline-powered double-drum slusher hoist and scraper and loaded into trucks by a diesel-powered front-end loader. The ore was transported to the heavy-media plant at the river.

The fracture zone can be traced for some distance northward up the hillside, but it decreases in width to about 10 feet. A few minor pits have been excavated on the extension of the zone to the south.

Shannon

The Shannon group of three unpatented claims lies near the southwestern end of the Artillery Mountains district in the unsurveyed north half of sec. 1, T. 11 N., R. 14 W. The property is accessible on a short side road branching northwest from the Yucca road about 7.5 miles northwest of Alamo crossing.

The original claims are said to have been located early in the district's history by Andy Shannon. Some years later they were acquired by the present owner, the Arizona Manganese Corp., of Chicago, Ill. As originally located, the group consisted of nine claims, some of which extended north into sec. 36 owned by the State of Arizona. Later the claims on the State land were dropped, and late in 1955 the locations were amended to cover the present group

The first output of record was produced in 1954, when the property was leased by Ike W. Kusisto, of Wickenburg, Ariz. At that time approximately 50 tons of sorted ore averaging about 15 percent manganese was shipped to the Government purchasing depot in Wenden, Ariz. Late in 1955 the property was held under a lease agreement by O. L. Jaggers of the World Manganese Corp. At the time of the visit in mid-December 1955 the eastern part of the deposit was being explored by the lessee.

Manganese mineralization occurs along a broad, irregular zone trending east through the Sandtrap conglomerate. The zone is mineralized in places for nearly 2,000 feet along its strike and up to 150 feet in width. It contains both manganiferous beds and manganese-bearing fractures that cut the beds.

In the western end of the property the zone crops out along a ridge exposing an irregular mineralized area roughly 400 feet long and as much as 150 feet wide. In this area the manganiferous conglomerate beds have been disturbed by faulting and folding so the dip of the zone as a whole is uncertain. The southern margin of the deposit is very irregular, and alluvium overburden lies adjacent to much of its northern side. To the west the mineralized area tapers and pinches out entirely against steeply dipping fractures striking east. Better-than-average grade material found along some of these fractures constituted the ore that was shipped to the Wenden depot. The workings in this area were limited to a few shallow opencuts and pits.

Another manganese-bearing area several hundred feet to the northeast is exposed in places for over 1,000 feet along the strike. In several opencuts where exposed it consists of manganiferous beds interlayered with barren beds forming a zone up to 70 feet thick. The manganese-bearing beds range from a few inches to 18 inches in thickness and usually are separated by unmineralized material of like thickness. The zone appears to dip about 45° N. and in places contains steeper dipping manganiferous fractures of various attitudes. At the time of the visit this zone had been crosscut by 3 opencuts spaced 200 to 400 feet apart in a distance of some 800 feet along the trend of the mineralization. The cuts were about 20 feet wide, up to 100 feet long, and 15 to 20 feet deep at the face. The overburden had been stripped from the zone in several areas surrounding the cuts. The mineralized material removed from the openings was stockpiled nearby for future treatment in the concentrating plant originally built by F. A. Sitton and recently acquired by the World Manganese Corp.

The manganese minerals in the deposits consist essentially of wad, pyrolusite, and psilomelane. The wadlike oxides impregnate the sandy matrix and surround pebbles in the conglomerate beds, whereas pyrolusite and psilomelane are the most abundant along the fractures cutting the formation. The chief gangue minerals are calcite, quartz, and small amounts of barite.

Lone Star

The Lone Star group of three unpatented claims is at the northwestern end of the Artillery Mountains district in NW¼ sec. 36 and SW¼ sec. 25, T. 12 N., R. 14 W. That part of the group lying in sec. 36 is on land owned by the State of Arizona. The claims in sec. 25 are owned by the Arizona Manganese Corp., of Chicago, Ill., and those in sec. 36 are held by the same company under a lease from the State. The property is accessible over some 2 miles of road that branches northward from the Yucca road about 7 miles northwest of Alamo crossing.

The claims were acquired in the late 1920's by the Arizona Manganese Corp. The first ore was produced during 1954, when the property was leased to the Mohave Mining & Milling Co. During that year the company did some exploration work and mined a few hundred tons of ore, which was milled in its plant on the Bill Williams River. The resulting concentrates, approximately 79 long tons averaging 22.6 percent manganese, were shipped to the Government purchasing depot in Wenden, Ariz. Late in 1955 a lease-option agreement on the property was obtained from the Arizona Manganese Corp. by O. L. Jaggers of the World Manganese Corp.

The deposit occurs in a part of a basalt flow that rests upon the Sandtrap conglomerate. The basalt crops out for several hundred feet

along the east side of a steep bluff overlooking the upper end of Sandtrap Wash. As exposed in this area, the basalt is as much as 40 feet thick. However, the manganese mineralization is confined largely to a zone in the flow ranging from 6 to 10 feet in thickness, which occupies the upper part of the outcrop along the top of the bluff. This mineralized member appears to be more vesicular and scoriaceous than the underlying barren basalts. It dips gently southwest and a short distance down the dip is overlain by a light-colored barren basalt, which may be later in age. The northeastern part of the mineralized area has been downthrown about 20 feet by a normal fault striking N. 60° W. and dipping about 60° NE.

The deposit had been exposed largely by bulldozer stripping in an irregular area roughly 100 feet wide and 400 feet long. In the area exposed the manganese minerals, chiefly pyrolusite and some manganite, occur in seams, veinlets, and irregular masses distributed erratically in the basalt. Iron oxides and calcite are the principal gangue minerals.

Blossom Group

The Blossom group, sometimes known as the River View group, comprises three unpatented claims covering part of SE¼ sec. 12, T. 11 N., R. 13 W., and extending into the extreme southwest corner of sec. 7, T. 11 N., R. 12 W. The group lies in the bottom lands along the Bill Williams River about half a mile north of Brown crossing.

The claims originally were located in 1942 by J. E. Rodgers and Roy L. Fulton. During 1954, 281 long tons of sorted ore averaging 17.7 percent manganese was shipped by Floyd Brown to the Government purchasing depot in Wenden, Ariz. In June 1955 the claims were purchased by F. A. Sitton and later that year were acquired by the World Manganese Corp. The property was idle when the area was visited in February 1956.

Manganese mineralization on the claims is exposed in several places along beds in the upper part of the Chapin Wash formation. The manganiferous beds crop out near the eastern end of the property and locally near its western end. Alluvium overburden covers much of the intervening distance. Where exposed, the manganese-bearing beds range from 2 to 8 feet in thickness, strike northwest, and dip 10° to 15° SW. Several scattered outcrops in the western part of the property were explored by pits and bulldozer stripping. Near the eastern end of the group the overburden had been stripped from a mineralized bed in 2 irregular areas about 300 feet apart. The east area exposed the mineralization for approximately 100 feet along the strike and for 150 feet down the dip from the outcrop. To the west, the manganiferous bed was exposed in an area roughly 60 feet along the strike and 100 feet along the dip. Several shallow pits and cuts had been excavated within the stripped areas. Floyd Brown informed the writer that parts of these stripped areas, as well as those near the west end of the property, had been explored by wagon-drill holes. The cuttings from some of these holes were said to have contained 12 to 15 percent manganese.

The chief manganese mineral is amorphous wad rather uniformly distributed in the sand grains composing the bed. In places the bed has been enriched by stringers and small irregular masses of the harder manganese oxides.

Concentrating Plants

When F. A. Sitton began operations early in 1955, he moved the log-washing plant used by Al Stovall from its original location at Brown crossing to the present site about one-half mile upstream. The plant was constructed on a mobile trailer unit. The flow sheet is shown in figure 16.

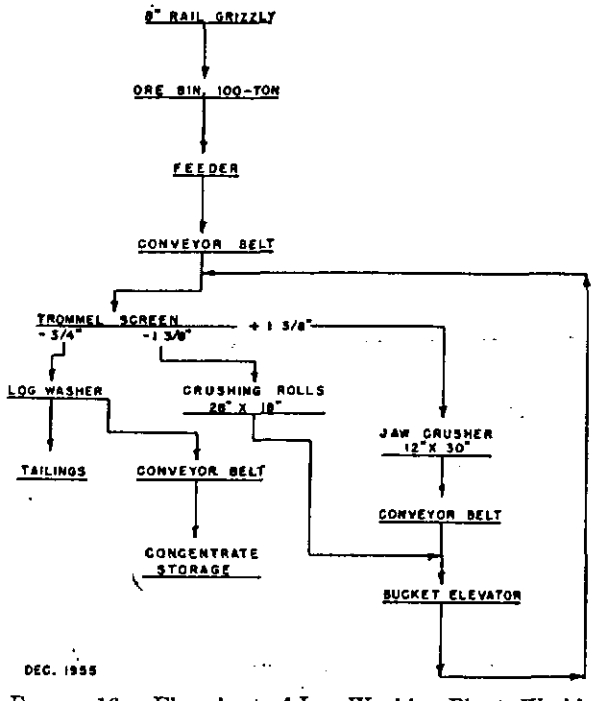


FIGURE 16.—Flowsheet of Log-Washing Plant, World Manganese Corp.

Early in the year Sitton also began construction of a concentrating mill having a capacity of 1,000 tons per 24 hours. This plant, completed in mid-1955, was a combination of jig and heavy-media separation (fig. 17). The flowsheet is shown in figure 18.

These mills were acquired by World Manganese Corp. about December 1955.

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Plants

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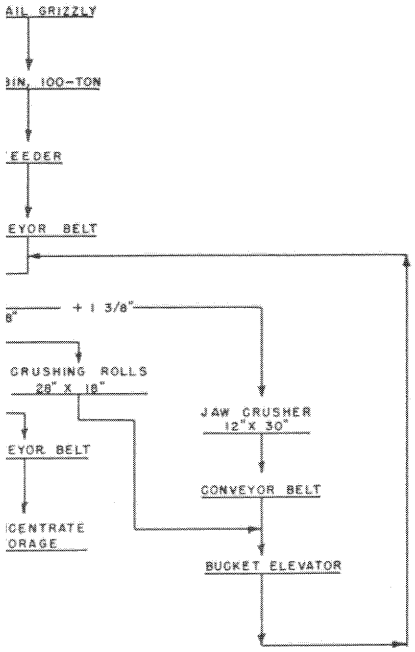

lowsheet of Log-Washing Plant, World Manganese Corp.

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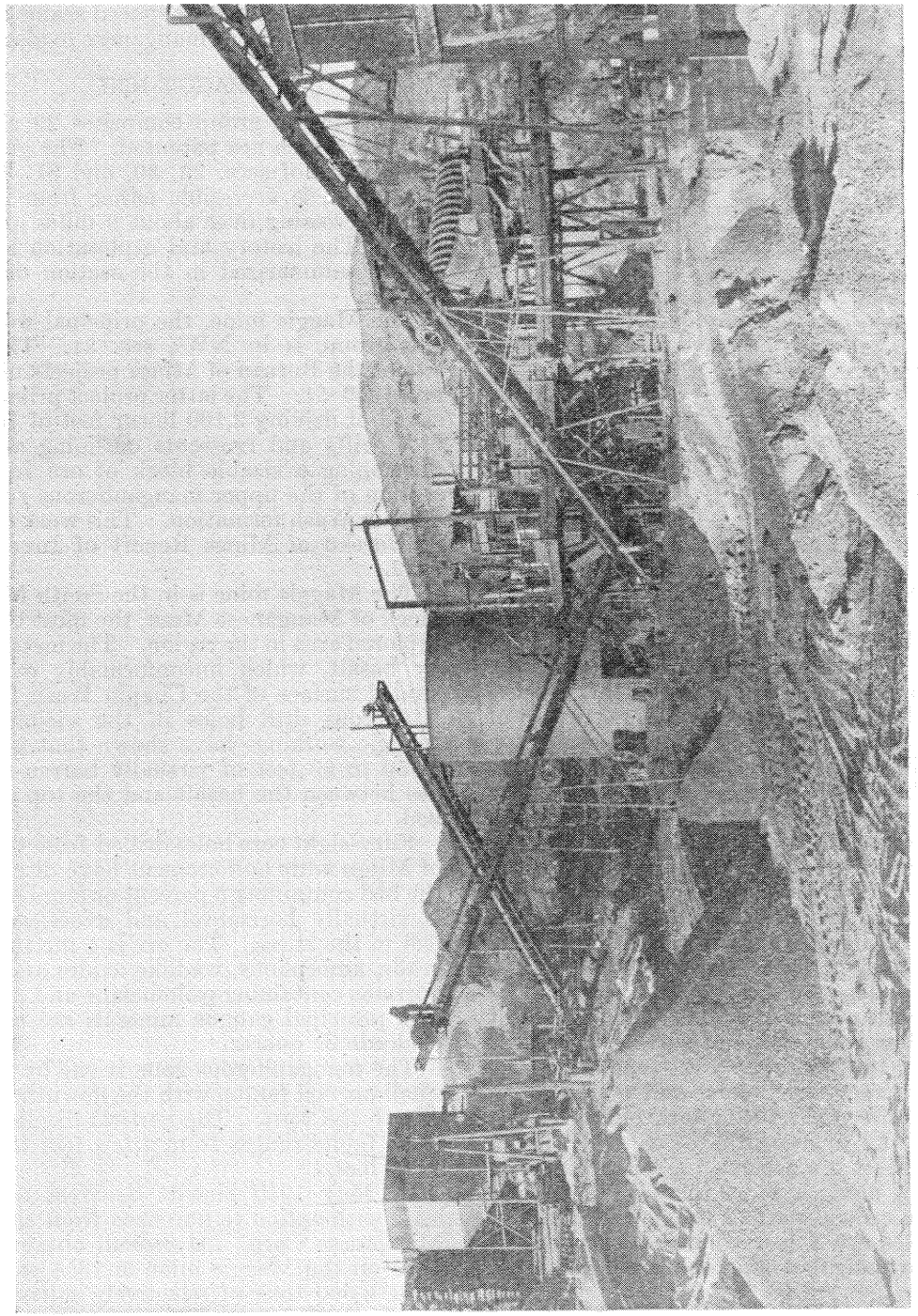

FIGURE 17.—Concentrating Plant, World Manganese Corp.

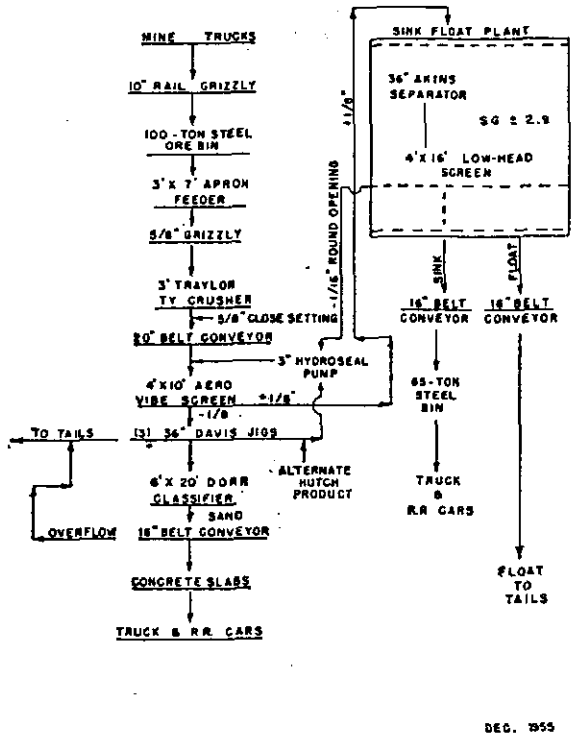

FIGURE 18.—Mill Flowsheet, World Manganese Corp.

RUDY

The Rudy group of 2 patented and 5 unpatented claims covers parts of SW¼ sec. 31, T. 12 N., R. 13 W., and NW¼ sec. 6, T. 11 N., R. 13 W. The claims can be reached over the Brown crossing road, which passes through the center of the group about 7.5 miles northwest of the Bill Williams River (fig. 9).

The claims were located originally in 1918 by S. K. Barbee [10] and were called the Nigger Boy group. In the late 1920's they were acquired by the Arizona Manganese Corp. and are now held under a lease-option agreement by Manganese, Inc., of Henderson, Nev. Although it is reported that some ore was shipped earlier, the only shipments of record were some 15 tons averaging 36.5 percent manganese shipped to the Wenden depot in 1953 by H. S. West.

The deposit occurs in a steeply dipping fault zone trending southeast and cutting the basalt member of the Sandtrap conglomerate. The zone contains scattered seams and veinlets filled with manganese oxides for about 250 feet along the strike and over widths of as much as 75 feet. The best ore occurs in a series of lenticular masses along a more intensely shattered area in the central part of the zone. Some of these masses are 2 feet wide and several feet long. The manganese minerals are psilomelane and some manganite occurring in a gangue of calcite and quartz. The central part of the zone had been explored by 3 shallow opencuts ranging from 10 to 25 feet in length.

Approximately 1,000 feet southeast of these workings the alluvium overburden had been stripped by bulldozers from areas several hundred feet square. In part of these areas the basalt contained widely spaced seams and small irregular bunches of manganese oxides.

MAGGIE MINE

The Maggie group comprises 29 claims, all but 2 of which are patented. The group, covering parts of secs. 29, 30, and 31, T. 12 N., R. 13 W., is accessible either from Alamo or Brown crossing over about 9 miles of fair dirt road. The history and exploration have been briefly summarized in the section on History (p. 29).

The Maggie mine, the principal workings in this group, is in NW¼ sec. 31. This is the site of the Bureau of Mines projects of 1940–41 and 1949–51. The latter project primarily consisted of driving 2,100 linear feet of 10- by 10-foot drifts and crosscuts outlining and partly developing a sizable block of ore in the top section of the upper manganiferous zone of the Chapin Wash formation. This work is detailed in Bureau of Mines Report of Investigations 5292.

The Maggie mine is in the South Maggie ore block of Manganese Mesa, the most thoroughly explored area in the region. The mesa is capped by basalt, which unconformably overlies the eroded surface of the Chapin Wash formation. Numerous drill holes in the vicinity of the Maggie workings have shown that an average of 50 to 60 feet of virtually barren sandstone lies between the basalt and the top of the ore bed.

Fifty-eight core holes drilled from the Bureau of Mines adits and crosscut have disclosed that the bed containing 5 percent or more manganese is virtually horizontal and averages some 20 feet in thickness. The ore is a mixture of low-grade, amorphous, wadlike oxides and enriched portions containing psilomelane and manganite. The principal gangue minerals are calcite and chalcedonic quartz.

The manganiferous zone is cut by numerous small normal faults, with the downthrow generally to the west. The vertical displacement of these faults ranges from a few feet to as much as 30 feet.

In May 1950 Hewitt S. West obtained a lease with option to purchase from the Arizona Manganese Corp. Al Stovall obtained a sublease on the Maggie mine in 1954 and shipped some 8,500 tons of selectively mined ore that averaged 16.2 percent manganese. This pro-

[10] Jones, E. L., Jr., and Ransome, F. L., Deposits of Manganese Ore in Arizona: Geol. Survey Bull. 710 (d), 1920, pp. 93–184.

duction was obtained from a labyrinth of interconnected stopes developed along the Bureau drifts and crosscuts (fig. 19). In June 1955 West assigned the original lease to Manganese, Inc., of Henderson, Nev.

Stovall mined the ore only from the higher grade beds of the deposit. The broken ore was removed from the stopes with slusher hoist and scraper and trucked to the Government purchasing depot in Wenden. The outcrop of the ore bed west of the old Maggie adit was stripped, and a bench cut 150 feet long by 20 feet wide was blasted. Apparently the production from this cut was insignificant, as much of the broken material was not moved.

When visited in February 1956, the property was idle, and all equipment with the exception of the ore bin had been removed.

LAKE DEPOSIT

The recently productive workings on the Lake property are in the west central part of SW¼ sec. 33, T. 12 N., R. 13 W., on a patented claim constituting one of 20 contiguous patented claims known as the Chapin group. The principal workings are in the northern end of Chapin Wash about 6 road miles northwest of Brown crossing on the Bill Williams River.

The claims were acquired in 1929 by the Chapin Exploration Co.; they were later leased to the M. A. Hanna Co. and then transferred to M. C. Lake. The group is now owned by the M. C. Lake estate. In 1953 Al Stovall, of Phoenix, Ariz., obtained a lease on part of the property and during 1953 and 1954 shipped 33,126 long tons of crude ore averaging 18.8 percent manganese to the Government purchasing depot in Wenden, Ariz. The property was idle when the area was visited in February 1956.

The ore was mined in open pits from a bed in the upper manganiferous zone of the Chapin Wash formation. The zone in this part of the district crops out along Chapin Wash in a broad belt trending northwest for nearly 3,000 feet. The productive area, exploited by Stovall, occupies the southern end of the outcrop. Most of the ore was mined from an enriched "hard ore" bed ranging up to 6 feet in thickness and dipping 10° to 19° SW. The main workings, an open pit about 500 feet long, follow the bed down the dip for as much as 300 feet (fig. 20). The overburden had been stripped from

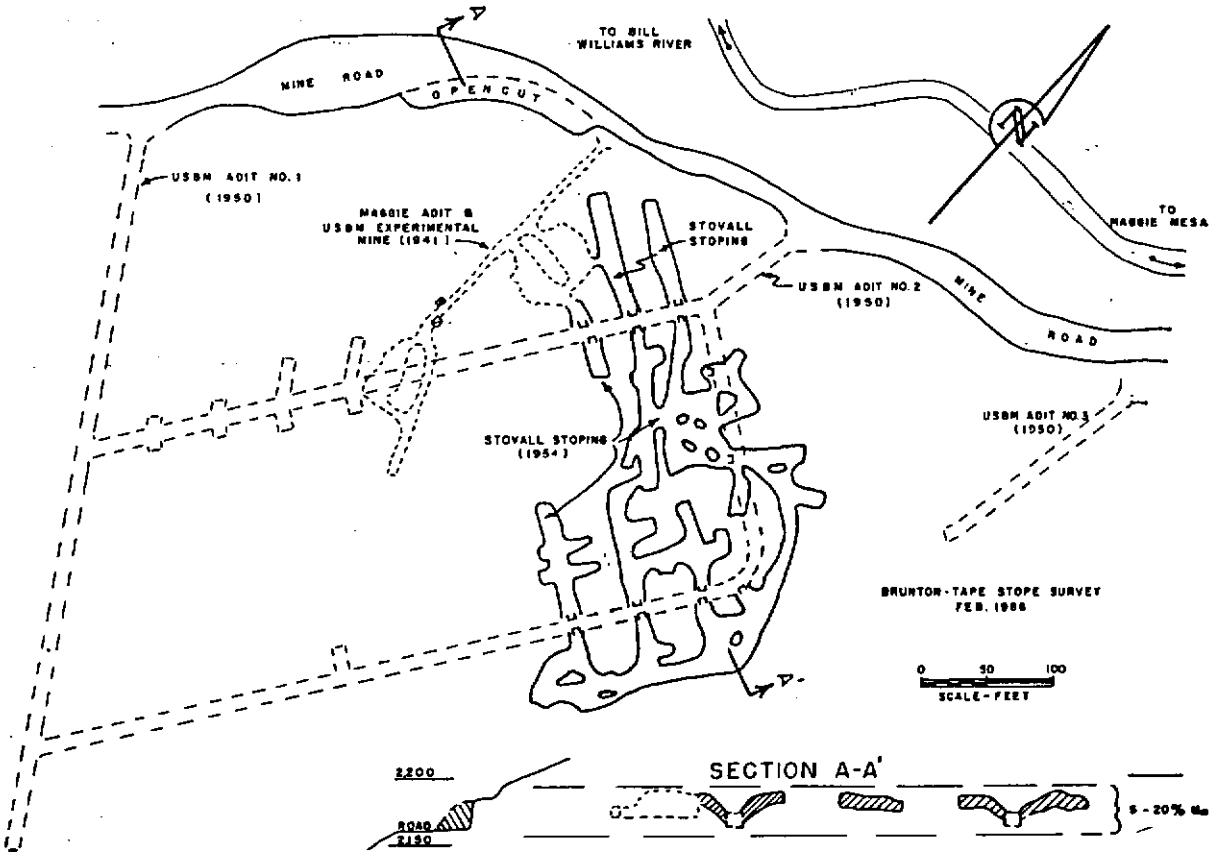

FIGURE 19.—Plan and Section, Maggie Mine.

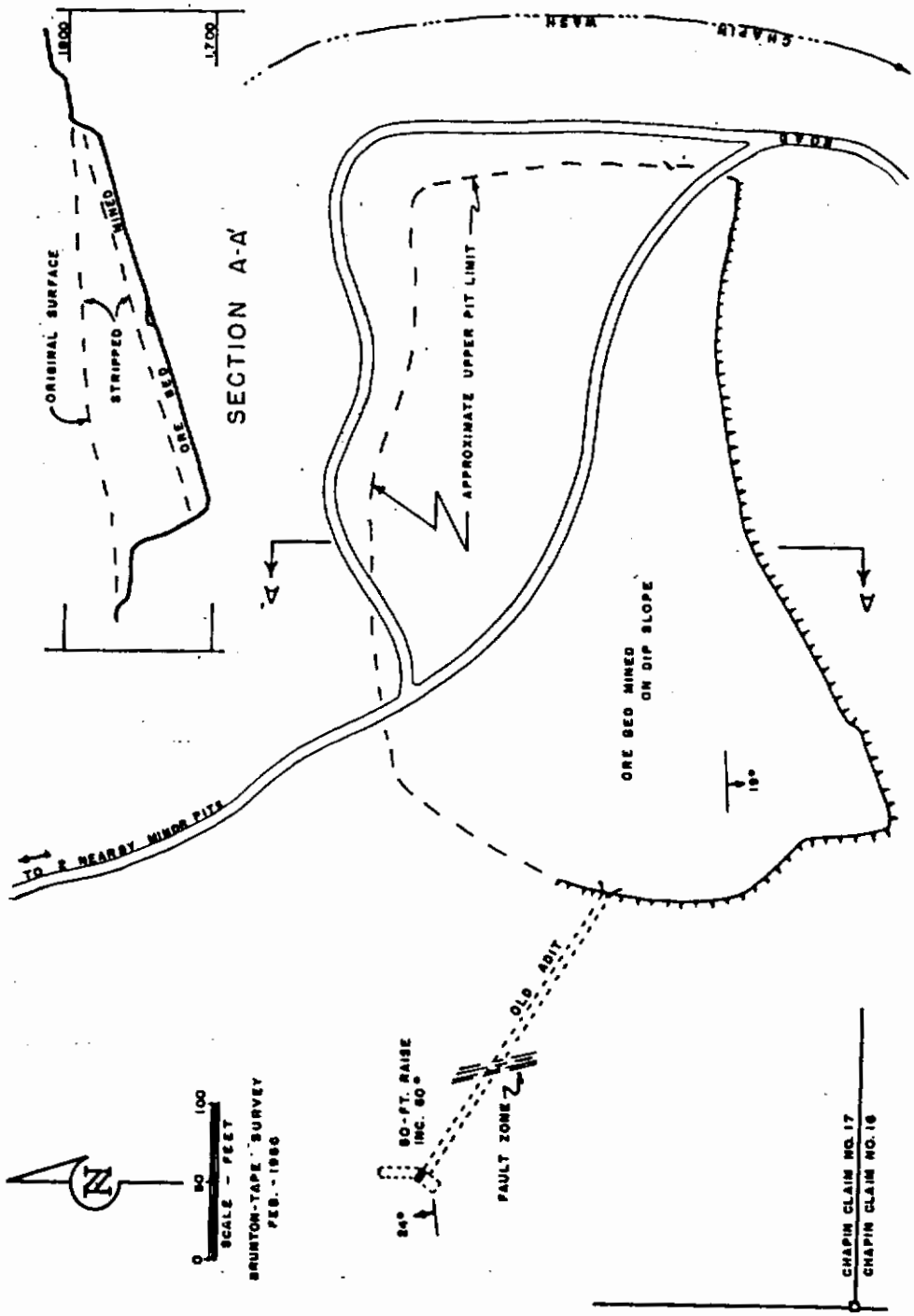

FIGURE 20.—Plan and Section, Lake Pit.

the bed in scattered areas several hundred feet to the north and northwest of the main pit. However, little ore appeared to have been mined from these areas. At the upper or north side of the large pit very little overburden covered the ore bed, but as the work progressed down the dip lower grade or barren material over the ore increased until at the south face of the opening the overburden in places was 20 feet or more thick.

In the mining and stripping operations heavy equipment was used, including bulldozers, rippers, carryalls, and front-end loaders. Both the overburden and the ore were soft enough that they required no explosives.

In the west end of the main pit an exploratory adit, driven many years ago, extended northwest for some 220 feet. At its face a steeply inclined raise, now inaccessible, had been driven to an estimated height of 50 feet. About 130 feet from its portal the adit was crossed by a northward trending fault zone, which appeared to have displaced the beds and thrown them upward along its west side. The extent of displacement was not evident, but it appeared that the raise was driven to explore the beds in the upthrown segment of the fault.

The manganese minerals consist of wad, psilomelane, and pyrolusite occurring in gangue of sandstone and clay.

PSILOMELANE GROUP

The Psilomelane group of five contiguous unpatented claims was located by S. J. Love, the present owner, in 1950. The claims are in the west central part of sec. 3, T. 11 N., R. 13 W., on both sides of Chapin Wash. The property is reached over the Chapin Wash road, approximately 4½ miles from Brown crossing.

Psilomelane No. 1

The productive workings on this claim were developed by Al Stovall under a lease agreement in 1953 and 1954. A total of nearly 20,000 tons of crude ore averaging 18.4 percent manganese was shipped to the Wenden purchase depot, most of which was mined by Stovall. Late in 1954 R. F. Monnahan, and S. J. Love, produced 5 and 14 percent of the total tonnage, respectively.

The deposit is in the upper manganiferous zone of the Chapin Wash formation. In this area, which lies in the downthrown segment between the Plancha Mountain and Common Corner Faults, the beds are tilted and warped. On the ridge immediately east of Chapin Wash the mineralized beds crop out in an isolated crescent, the limbs of which dip as much as 30° toward the axis of the warp. This part of the deposit has been mined by a series of relatively shallow open stopes ranging from 8 to 12 feet in height.

On the west side of the wash an inclined shaft has been driven S. 85° W. for at least 300 feet down the dip of the manganiferous bed. The dip changes from 25° to 13° about 180 feet from the shaft collar. The deposit was worked by open stopes from at least three levels, driven north and south from the shaft. The property was inactive when visited in February 1956, and because of rock falls and other hazardous conditions only parts of the mine could be examined. The lower part of the mine contained an accumulation of water and mud from surface flooding.

The drifts north of the shaft, driven on a haulage grade, followed the warped beds and veered northwest. The drift at the 150-foot (inclined) level was open and extended about 400 feet from the shaft. The 200-foot level was accessible for 200 feet north of the shaft and appeared to extend an equal distance farther. Except for pillars, the mineralized zone updip from these drifts was stoped to the surface.

On the south side of the shaft the 200-foot level was open for 100 feet to the face and appeared to be similarly stoped to the surface. The probable dimensions of the deposit mined from the shaft are: Strike length, 500 feet; dip depth, 200 to 250 feet; and thickness, 8 to 12 feet.

The ore mined from the deposit appears to have occurred in that part of the manganiferous zone where the original bedded material was enriched along shears and fractures associated with the deformation of the beds.

Mining was conducted in relatively flat stopes above each drift level, from which the broken ore was moved by slusher hoist and scraper through chutes into mine cars. The cars were trammed to the shaft, dumped into a skip, and hoisted to the surface for transportation to Wenden.

Psilomelane No. 4

The workings on the Psilomelane No. 4 claim are approximately 1,000 feet northwest of the Psilomelane No. 1 shaft in the same mineralized beds. A 12° inclined shaft on the west side of Chapin Wash exposes a 2- to 3-foot mineralized bed for 100 feet down the dip, of which 50 feet is in an inclined opencut. Immediately west of the portal, four closely spaced minor step faults drop the mineralized bed a few feet to the east.

The mineralization of this deposit consists of the wadtype oxides disseminated throughout the sandstone and intimately associated with an abundance of very small blebs of white

calcite. Virtually no hard oxides were observed.

The inclined shaft was driven early in 1955 by Mr. Love, using a slusher hoist and scraper. The property was idle when visited in February 1956.

About 100 feet east of the shaft the same mineralization occurred in beds exposed by an opencut in the east bank of Chapin Wash.

BLACK JACK

The Black Jack group of three unpatented claims is approximately one-half air mile north-northeast of the Priceless pit in the center of SW¼ sec. 1, T. 11 N., R. 13 W. The deposit is reached by a steep, rough, truck trail from the north end of the Priceless pit.

The claims were located by Roy Eaton, who later sold them to S. J. Love, the present owner. The Arizona Metals Co., of Wenden, Ariz., leased the property and shipped 1,230 long tons of sorted crude ore containing 20.6 percent manganese to the Wenden purchasing depot in 1954. The property was inactive when visited in August 1955. The major work consists of a 120-foot adit driven N. 35° W. and a 60-foot branch driven N. 60° W. from 20 feet within the main adit. Both drifts have been connected by raises or open stopes into surface cuts up to 40 feet above. A 12-foot pit 6 feet wide and 15 feet long had been excavated outside the portal.

The longer adit follows a fault contact of the Artillery formation against granite to the northeast. The branch adit follows a fork of this fault and cuts into the Artillery formation. Both faults dip steeply west. An ore body of 6 to 8 feet of manganiferous material has been mined along these fault zones. The gangue minerals are barite and calcite.

On the hillside about 500 feet southeast of the main workings a small lens of manganese ore was opened by a short adit, from which a raise connected to a small surface cut above. The vein here is 2 to 3 feet wide and is a continuation of the vein that follows the major fault contact.

PLANCHA MOUNTAIN GROUP

The Plancha Mountain group of six contiguous unpatented claims is owned by S. J. Love, who maintains a home in the Artillery Mountains area. The claims are in the east central part of sec. 4, T. 11 N., R. 13 W., and cover much of the upper part of a flat lava-capped mesa known as Plancha Mountain.

The major work has been confined to a small area on the east side of the mountain near the quarter corner common to secs. 3 and 4. The workings are accessible over one-half mile of steep truck trail that branches northwest from the road into Chapin Wash.

A 140-foot adit bearing S. 85° W. has been driven into a manganiferous bed that lies in the upper part of the Chapin Wash formation. The mineralized bed is about 12 feet thick, strikes north, dips 5° to 7° W., and crops out in places for approximately 250 feet along the strike. Talus overburden covers any further extension of the bed along the strike. The adit, following the mineralized beds downdip, was carried about 12 feet high for 100 feet, and then the back was stepped down to a 7-foot height to the face.

Manganese mineralization consists of amorphous, wadlike oxides that are more or less uniformly distributed through the beds that have been exposed in the adit. As there has been no enrichment of this bedded deposit, virtually no hard oxides are present. Love states that several assays showed an average manganese content of about 12 percent. A bulldozer cut along the outcrop for 200 feet south of the adit has exposed the same beds containing similar mineralization.

No ore had been shipped from the deposit, and it was idle when examined in February 1956.

BLACK CROW GROUP (NEILSON)

The Black Crow group of two unpatented claims is in the west central part of NW¼ sec. 33, T. 12 N., R. 13 W., on the east side of Chapin Wash. The claims were first located in 1950 by Les Neilson and were purchased by S. J. Love, the present owner, in 1954. The property is accessible by a short branch road turning east from the Chapin Wash road approximately 7 miles from Brown crossing.

The Wenden purchase depot records indicate that during 1953 and 1954 Neilson shipped 287 tons of crude ore containing 18.6 percent manganese from this property. The property was idle when the area was visited in February 1956.

Manganiferous beds of the Chapin Wash formation crop out in two areas on the property. In this part of the district the Chapin Wash formation is exposed in a belt several hundred feet wide that trends northwest. It dips gently southwest and is bordered on the northeast by the older granitic rocks. The southwest section of the belt is covered by the detrital material in Chapin Wash. The principal manganiferous beds in the formation occur in different zones apparently separated stratigraphically by several tens of feet of unmineralized sediments. The lower zone to the northeast was explored by a westerly trending opencut about 200 feet long, 12 feet wide, and up to 12 feet deep. In the cut the manganiferous zone exposed was about 12 feet thick and was composed of strongly mineralized beds 2 to 5 feet thick, which were separated by various thicknesses of

poorly mineralized or barren layers of sandstone and clay.

About 350 feet to the southwest the upper manganiferous zone had been explored by a bulldozer cut some 80 feet long, 10 feet deep, and 12 to 80 feet wide. The mineralization exposed in this opening was of the same type as that found in the opencut to the northeast.

The chief manganese minerals are soft wadlike oxides associated with minor amounts of psilomelane and manganite. The latter minerals are found largely in seams and fractures that cut the beds.

Approximately 300 feet northeast of the northern opencut manganese mineralization occurs along a fracture in the Precambrian granitic rocks. The fracture strikes N. 20° E., appears to dip steeply eastward, and was exposed by stripping for about 250 feet along the strike. In places the fracture contains irregular mineralized pods as much as 2 feet wide and several feet long.

BLACK WARRIOR NO. 11 (HURLEY)

The Black Warrior No. 11 claim, adjacent to the Psilomelane group on the southeast, is owned by R. B. Hurley, of Phoenix, Ariz. The claim is in the west central part of sec. 3, T. 11 N., R. 13 W., and can be reached by the same road that passes through the Psilomelane group.

A 180-foot inclined shaft was driven S. 70° W. down the 22° dip of a manganiferous bed. This bed appears to be a continuation of the same zone that was mined from the Psilomelane No. 1 shaft workings, some 300 feet to the north. At an inclined distance of 130 feet from the shaft collar a drift followed the ore bed 175 feet southeast. From this drift stub drifts were driven updip 50 feet and downdip 20 feet. No stoping was done.

The work was done under a lease agreement by Ike Kusisto in 1954. Eighty long tons of ore averaging 10.6 percent manganese was shipped to the purchase depot at Wenden. All the material that was mined was moved to the surface by means of a slusher hoist and scraper.

Manganese mineralization consisted of amorphous, wadlike oxides distributed more or less uniformly throughout a 4- to 6-foot bed that was exposed in the shaft. Virtually none of the hard oxides were present. The sandstone gangue was intimately associated with an abundance of very small blebs of white calcite.

On the adjacent Black Warrior claim to the southeast manganiferous beds crop out on the west side of Chapin Wash. From minor workings on this deposit a small amount of ore was shipped to the Wenden depot by R. B. Hurley and H. V. Bosley, Jr., in 1954.

LAST CHANCE

The Last Chance property comprises two claims in the western part of the Artillery Mountains Region on land owned by the State of Arizona. The claims comprise 40 acres covering the NE¼NE¼SW¼ and the NW¼NW¼SE¼ sec. 36, T. 12 N., R. 14 W. The area is accessible over 1.5 miles of road that branches north from the Yucca road about 7 miles northwest of Alamo crossing on the Bill Williams River.

In 1953 the claims were located, and a lease was obtained from the State by R. S. Rodgers, of Alamo, Ariz. Operations were begun soon thereafter and continued until early in 1955. During this period Rodgers shipped about 180 long tons of ore averaging 34.4 percent manganese to the Government purchasing depot in Wenden, Ariz. The property was idle when visited in February 1956.

High-grade manganese oxides were mined from small ore shoots occurring along the western end of a fault zone cutting the Sandtrap conglomerate. The fault strikes eastward, dips 50°–70° N., and can be traced along the surface for at least 1,000 feet. It is manganiferous in places throughout most of its extent. West of Sandtrap Wash the fault zone gradually loses its identity. Several hundred feet east of the wash it cuts the basalt member of the Sandtrap formation. Where intersected by the fault, the basalt contains manganese-bearing fractures.

The ore was produced from two ore shoots which cropped out along the fault zone on opposite sides of Sandtrap Wash. The west ore body was about 150 feet long and 1 to 3 feet wide. Near the center the ore shoot was intersected at an acute angle by a narrow fracture striking northeast, which evidently was ore bearing for several tens of feet beyond its intersection with the main ore shoot. The ore was mined from both deposits in more or less continuous opencuts driven along the strike of the mineralization. Most of the cuts had been backfilled, so their actual depths were not observable.

The other ore body, approximately 100 feet east across the wash, was mined for about 80 feet along the strike and up to 3.5 feet in width. Like the west ore shoot, it was intersected by narrow mineralized fractures along the north side of the main fault zone. The ore in the east body was mined to the surface in open stopes above an adit level. The deepest part of these workings was approximately 30 feet below the outcrop.

The chief manganese minerals were psilomelane and manganite. Calcite was the most abundant gangue mineral.

BLACK MARY

Black Mary is a single unpatented claim lying in the extreme northeastern corner of sec. 1, T. 11 N., R. 14 W., and extending for a short distance into adjoining sec. 6, T. 11 N., R. 13 W. It is about 8 miles by road northwest of the Bill Williams River and can be reached on either the Brown crossing road or the Alamo-Yucca road.

The claim was located in 1953 by E. W. Tate, of Yucca, Ariz., and a year later was acquired by the present owners, J. E. Robinette and associates, of Wenden, Ariz. During 1954 the deposit was explored by bulldozer stripping and trenching. As far as known, no ore has been shipped from the property; it was idle when the district was visited in February 1956.

Manganese oxides in the form of stringers, veinlets, and irregular lenticular masses occur in the claim along a steeply dipping shear zone cutting the Sandtrap conglomerate. The zone strikes N. 60° W., ranges up to 150 feet in width, and is exposed in places for about 400 feet along the strike. The manganese-bearing fractures range from mere seams to veinlets several inches wide. They are much more numerous in some parts of the zone than in others. The manganiferous lenses occur sporadically and in places are as much as 2 feet wide and tens of feet long. They appear to be most abundant along the northeast side of the zone.

In addition to the stripping, the deposit had been explored by several scattered cuts and pits having a maximum depth of approximately 10 feet.

Pyrolusite and manganite are the predominating manganese minerals. Calcite, both white and black, is the chief gangue mineral.

POLIANITE GROUP

The Polianite group of 5 claims is on State land in E½ sec. 36, T. 12 N., R. 14 W., about 8.5 miles via the Brown crossing road northwest of the Bill Williams River.

The claims were located and leased from the State of Arizona in 1953 by E. W. Tate, of Yucca, Ariz. During 1954 they were subleased by Tate and operated by Johnson and McBride. Early in 1955 the sublease was canceled, and Tate transferred his lease on the west claim (No. 5) to J. E. Robinette, P. T. Evans, and D. C. Evans, of Wenden, Ariz. As far as known, Tate still holds the State lease on the remaining four claims.

The production from the property has totaled some 1,600 long tons of ore that averaged close to 21 percent manganese. The bulk of this ore was mined by Johnson and McBride during 1954 and shipped to the Government purchasing depot in Wenden, Ariz. Early in 1955, before the Wenden depot closed, E. W. Tate shipped several small lots of ore from the claims. The property was idle when the district was visited in February 1956.

The manganese deposits occur in comparatively narrow lenticular shoots along parallel fractures cutting the Sandtrap conglomerate. The mineralized fractures strike eastward and dip steeply north. The principal ore body—in the eastern part of the property—has been mined continuously in an opencut for approximately 250 feet along the strike and to a maximum depth of some 50 feet. The cut ranges from 5 to 8 feet in width. The broken ore was hoisted from the opening in a skip running on an inclined track that extended out of the east end of the workings.

About 250 feet south of the opencut a steeply inclined shaft, estimated to be around 50 feet deep, had been sunk on a parallel mineralized fracture approximately 4 feet wide. This fracture was exposed in places on the surface for about 100 feet along the strike. It was reported that no drifting or stoping had been done from the shaft.

A few hundred feet southwest of the shaft in an area largely covered with alluvium, a mineralized fracture was exposed for a short distance in a shallow opencut.

Another manganese-bearing fracture crops out on the west claim (No. 5), which is some 1,500 feet northwest of the main productive opencut. This fracture ranges from 2 to 8 feet in width, strikes N. 70° E., and can be traced more or less continuously for about 600 feet. It has been explored near its west end by an opencut 35 feet long and 10 feet deep. A short distance west of the cut the fracture narrows and soon loses its identity after crossing a minor transverse fault. Overburden covers the area east of the outcrop.

The chief manganese minerals in the various fractures are psilomelane, pyrolusite, and manganite. The gangue consists of unreplaced fragments and pebbles of the wall rocks, black and white calcite, and small quantities of barite.

BLACK MOLLIE

The Black Mollie group of 2 unpatented claims is in the NE¼SW¼ sec. 29, T. 12 N., R. 13 W., near the extreme north end of Chapin Wash, some 8 road miles northwest of Brown crossing on the Bill Williams River.

The claims were located in 1953 by the present owner, R. J. Carpenter, of Wenden, Ariz. During 1953 and 1954 a total of 614 long tons of ore averaging 18.3 percent manganese was shipped from the property to the Government purchasing depot in Wenden, Ariz. Part of this tonnage was shipped by R. J. Carpenter and

the balance by several lessees, including Floyd Brown, Johnson and McBride, and Don Levy. Operations were terminated late in 1954, and the property was idle when the district was visited in February 1956.

The manganese-bearing beds are in the upper part of the Chapin Wash formation and along a fault zone that cuts them. Ore was mined from the bedded deposits in several shallow opencuts and from underground workings in a vertical faulting zone striking southeast. The underground work consisted of a 40-foot inclined (30°) shaft, which followed the dip of a mineralized bed in the fault zone, and a drift from the bottom of the incline that extended S. 20° E. along the zone for about 30 feet. Some additional ore evidently was mined in the zone immediately west of the shaft from a shallow drift extending southeast for about 25 feet from the bottom of a pit 10 feet deep. This work appeared to be in a downthrown segment of the bed that was followed by the inclined shaft.

Approximately 300 feet southeast of the underground work on the opposite side of the ridge a manganiferous bed some 20 feet thick was exposed in an opencut 16 feet long and 12 feet wide. The bed in this area strikes N. 20° W. and dips about 30° SW. A short distance beyond the limits of the cut the outcrop of the manganiferous bed passed under a cover of detrital material. According to R. J. Carpenter, the ore shipped from this opening contained about 16 percent manganese.

A few hundred feet south several scattered opencuts exposed other manganese-bearing beds ranging from 1 to several feet in thickness. Stratigraphically, these appeared to be somewhat lower than the manganiferous beds to the northwest.

The chief manganese mineral in the unaltered beds was wad. The harder oxides, such as psilomelane, pyrolusite, and manganite, were present in places along zones of fracturing or faulting.

AMERICAN

The American group of seven unpatented claims is in NW¼ sec. 7, T. 11 N., R. 12 W., well up on the slope of the hills that border the valley along the northern side of the Bill Williams River (fig. 8). The group is accessible over more than a mile of road that branches north from the river about half a mile northeast of Brown crossing. The last part of the access road leading to the principal workings is very steep in places and is best negotiated in a jeep or truck.

The claims were located in 1937 by George and Joe Lewis. They are now owned by George Lewis, of Wenden, Ariz., and F. O. Peterson, of Kingman, Ariz. In 1954 F. A. Sitton obtained a lease on the group and completed a small amount of exploration work. As far as known, no ore has been shipped from the property. When the area was visited late in February 1956, Lewis and Peterson with the aid of two men were performing the annual assessment work on some of the claims.

Manganese mineralization occurs in parallel fractured and brecciated zones cutting the sandstone and conglomerate beds of the Artillery formation. The zones strike northwest and for the most part appear to dip very steeply northeast. They are manganiferous in places for as much as 100 feet in width and for several hundred feet along the strike. Where the zone crops out along the face of a steep bluff in the northeastern part of the property, it contains seams, veinlets, and small, disseminated nodular particles of manganese oxides in variable quantities across a width of approximately 100 feet. The western side of the zone was explored by an adit driven along the strike of a group of the wider mineralized fractures. The adit, said to be about 35 feet long, was blocked a short distance from the portal by broken material blasted from its back and sides. This material reportedly was broken to obtain a bulk sample for metallurgical testing. At the portal of the adit 3 veinlets of hard psilomelane were exposed in a width of about 10 feet across the back of the opening. The veinlets ranged from 2 to 12 inches in width and dipped steeply northeast. They were evident in the face of the bluff for several tens of feet vertically above the adit. Toward its eastern side the zone contained widely spaced seams and sporadic nodules of manganese oxides over a width of at least 100 feet. According to F. O. Peterson, the zone can be traced along its strike for several hundred feet northwest beyond the top of the bluff.

Several hundred feet southeast of the adit another mineralized fracture zone crops out in places along a hillside in an area largely covered with talus. As exposed in a few shallow cuts, the manganese mineralization in this zone appears similar in character to that found in the zone to the northeast. Because of the talus overburden, its extent is not evident.

In several places along the access road between the mineralized fracture zones, the sedimentary beds contain areas in which the small nodules of manganese oxides are quite plentiful. The nodules appear to have been deposited at the same time that the enclosing sediments were laid down.

INDIAN

The Indian is a single claim adjoining the southwest side of the American group in NW¼

sec. 7, T. 11 N., R. 12 W. It is about a mile north of the Bill Williams River and can be reached over a short road branching west from the access road to the American group.

The claim was located in 1938 by Rachel B. Thompson and later transferred to her brother, George Lewis, of Wenden, Ariz. The present owners are George Lewis and F. O. Peterson, of Kingman, Ariz. The property is undeveloped, and no ore has been produced.

Manganese mineralization occurs in parts of a broad brecciated zone cutting the conglomerate beds of the Artillery formation. The zone appears to be one of a related series of northwesterly trending sheared and brecciated zones with which the manganese mineralization is associated on the American, Needle Eye, Black Diamond, and Black Eagle properties. As exposed on the Indian claim, the zone is about 200 feet wide, strikes N. 45° W., and appears to dip about 70° NE. Within its borders seams and irregular veinlets of the harder manganese oxides crop out in several areas of more intense fissuring and brecciation. Some of the larger of these exposed mineralized areas range up to 30 feet in width and are as much as 100 feet in length.

The exploratory work was limited to a shallow adit about 20 feet long that had been driven along the western side of one of the larger mineralized outcrops. When the property was visited in February 1956, the owners were planning additional exploratory work on some of the more promising occurrences.

OVERSIGHT

The Oversight group of three unpatented claims is in SW¼ sec. 17, T. 11 N., R. 13 W., along the valley bordering the north side of the Rawhide Mountains. The property is readily accessible over less than a mile of road that branches east from the Yucca road about 4.5 miles north of Alamo crossing.

The claims were located in 1952 by the present owners, T. J. Rodgers, of Alamo, and John M. Neal, of Kingman, Ariz. During the following 2 years approximately 1,360 long tons of ore containing 10 to 20 percent manganese was shipped to the Government purchasing depot in Wenden, Ariz. Operations were suspended late in 1954.

Manganese mineralization occurs in sandstone beds which, according to Lasky,[11] are a part of the lower manganiferous zone of the Chapin Wash formation. As far as known, this property is the only one in the region that has produced appreciable quantities of ore from the lower Chapin Wash zone. Manganese-bearing beds of various sizes crop out in several places on the property. The largest of these, the one that produced the bulk of the ore, is exposed for several hundred feet along the surface, where it ranges from a few feet to as much as 12 feet in thickness. It strikes northwest and dips moderately southwest down the limb of a minor anticlinal fold. In the mined area the bed is cut by several steeply dipping fracture zones along which some displacement has taken place. Some of these fracture zones contain seams and veinlets of supergene manganese oxides, which locally enrich the bed.

The chief manganese minerals are wad, pyrolusite, and psilomelane. No doubt, the first is the original constituent in the sandstone, whereas the pyrolusite and psilomelane were introduced later, after the beds were fractured. Calcite is the chief gangue mineral.

The ore was mined largely in an opencut about 150 feet long, 6 to 10 feet wide, and up to 15 feet deep.

OTHER DEPOSITS

MESA MANGANESE

The Mesa Manganese group of 27 unpatented claims is 17 miles by road west of Alamo crossing in secs. 20 and 21, T. 11 N., R. 15 W. Though the property may be reached from Bouse, Ariz., it is most readily accessible from Alamo over about 15 miles of road that branches west from the Yucca road approximately 2 miles north of Alamo crossing.

The claims were located in 1949 by the present owners, T. J. Rodgers, of Alamo, and John M. Neal, of Kingman, Ariz. In 1953 the property was leased to the Stacey Bornt Mining Co., of El Centro, Calif. During the following year several hundred tons of ore was mined from different parts of the property. Although a small quantity of sorted ore was shipped direct, the bulk of the material mined was treated in a small gravity concentrating plant built on the Bill Williams River a few miles southwest of the claims. The crude ore and concentrates were shipped to the Government purchasing depot in Wenden, Ariz. The ore contained about 16.5 percent manganese and the concentrates 43 percent. All operations were suspended late in 1954.

The rocks exposed in the area include Precambrian granite and schist, Paleozoic limestone, Tertiary sandstones and volcanics, and later basalt flows that now cap the higher mesas. Manganese mineralization occurs in both the limestone and sandstone. In the limestone the ore is in steeply dipping fracture zones that cut the formation. The mineralization in the sandstone appears to be of the bedded type and is exposed in a few places in

[11] Lasky, S. G., and Weber, B. N., Manganese Resources of the Artillery Mountains Region, Mohave County, Ariz.: Geol. Survey Bull. 961, 1949, 86 pp.

reddish, sandy sediments resembling parts of the Artillery formation. These bedded-type occurrences are not well exposed, and their extent is not evident.

The more important deposits occur in a wide belt of altered limestone that crops out for several thousand feet along the northeast side of an extensive mesa.

The limestone, for the most part, is at least several hundred feet thick and in general strikes northwest. In places it appears to dip moderately southwest and in other places, presumably due to folding, it dips rather steeply in the opposite direction. Near the northwest end of the property the limestone rests upon schist and is overlain by basalt. Farther southeast in the vicinity of Centennial Wash, the limestone lies on Precambrian rocks and is overlain by thick beds of Artillery (?) sandstones, which in turn are capped by basalt.

Manganese mineralization occurs in several areas along the outcrop of the limestone. These are exposed principally near the northwest end of the property and some 2,000 feet southeast near the northern side of Centennial Wash. In the northwest exposure the limestone is marbleized and contains a network of manganiferous fractures and irregular podlike masses in a zone up to 200 feet wide and at least 300 feet long. The possible extension of this mineralized area is obscured by alluvium and talus overburden. The manganese-bearing fractures in the zone range from thin seams to veinlets several inches wide. They vary greatly in the number present in different parts of the zone. The podlike masses occur erratically and range up to a foot in width and from less than a foot to several feet in length. In parts of the outcrop the mineralized fractures and masses are closely spaced, and in other places they are separated by several feet of unmineralized limestone. Where they are numerous and closely spaced, they may form zones or bands of *better-than-average-grade material several feet* in width and up to tens of feet in length. The widest and more persistent fractures in the area trend N. 30°–35° W. and appear to dip almost vertically.

The zone had been explored by two opencuts driven along the strike of some of the better mineralized bands. One cut near the base of the mesa was about 30 feet long, up to 10 feet deep, and 5 to 12 feet wide. The other opening, about 125 feet to the west, was approximately 100 feet long, 6 feet wide, and 4 to 8 feet deep. A small pile of ore, evidently sorted from the material broken in the cut, was piled nearby.

The manganese deposits to the southeast near Centennial Wash are, in general, similar in type to those in the northwest end of the property, though perhaps less extensive. In this southeastern area the limestone is cut by a series of mineralized fracture zones striking for the most part northwest and dipping steeply northeast. Near the west side of the limestone belt 3 shallow opencuts ranging from 20 to 80 feet in length, exposed a mineralized zone in places for approximately 700 feet along the strike. The zone, as exposed by these openings, ranged from 10 to 15 feet in width; however, the full width of the zone may not have been exposed by this work, as much of the area adjacent to the cuts was covered with overburden. Approximately 250 feet east of the south cut and near the eastern side of the limestone outcrop, adit workings exposed an irregular mineralized area roughly 100 feet long and 50 feet wide. The adit was about 100 feet above Centennial Wash on a steep hillside and had been driven west about 60 feet. Three room-like stopes extended outward from the sides of *the adit 10 to 40 feet.* The largest of these openings was 20 feet wide in places and as much as 18 feet high. In this area the limestone was silicified and altered to a hard, dense mass resembling quartzite. The mineralization in this material appeared to be more uniformly distributed throughout the zone than in the other occurrences. However, the best ore evidently was the most abundant along and adjacent to the more prominent fractures.

The lessee had at one time operated a small screening plant in this area to upgrade the material mined in the adit workings.

The principal manganese minerals on the property are psilomelane and pyrolusite. The gangue is composed largely of altered limestone and calcite.

CASTENADA GROUP

The Castenada group of three contiguous unpatented claims is in the north half of sec. 24, T. 12 N., R. 16 W. The claims were located by John T. Moore in December 1953 as the Manganese Nos. 1 to 3. The name "Castenada" is applied because of the proximity of the claims to the Castenada wells to the northwest.

The deposit is 19 air miles northwest of Alamo crossing and is accessible from the El Paso Natural Gas Co. pipeline road by a 2.3-mile primitive road.

Although the property is undeveloped except by assessment pits, Moore shipped 11 tons of 39.2 percent manganese ore obtained by picking up float along and below the outcrop.

The deposit consists of manganiferous sediments of the Artillery or similar formation exposed on the northeast slope of a ridge trending northwest. Although the strike and dip of the bedding along the ridge varies considerably, the average strike appears to be N. 40° W. and the dip 15° NE. The normal thickness of the

mineralized beds is about 100 feet but appears considerably greater because the dip of the beds and the hillside slope are in the same direction. The mineralized formation is exposed more or less continuously for about 800 feet along the hillside. It is terminated on the northeast by a fault striking S. 55° E. and on the southwest by another fault striking S. 65° E. Both faults dip steeply northeast.

The low-grade mineralization within the bedding is enriched by supergene psilomelane and manganite occurring along numerous minor faults and fractures, which in general tend to parallel the major southeast faulting. Taken as a whole, the deposit appears to be low grade.

A 10- to 15-foot manganiferous bed crops out on the northeast side of a smaller ridge about 2,000 feet to the north. This appears to be in a bed stratigraphically higher than the major deposit.

BLACK BURRO

The Black Burro group of 3 unpatented claims is near the Bill Williams River about 8 air miles west of Alamo crossing. The claims lie approximately in unsurveyed sec. 20, T. 11 N., R. 14 W. They are most readily accessible from Bouse, Ariz., over about 33 miles of branching desert roads. The property may be reached from Bouse by traveling northeast on the old Planet road for 13 miles to a road fork, thence on the right branch for 11 miles to the intersection of 3 roads, and from there northeast on the left fork for some 6 miles to the Johnson ranch on the Bill Williams River, which must be forded at this point; the deposit is 2.6 miles northeast of the river crossing.

The claims were located in 1952 by the present owner, William D. Goyn, of Wenden, Ariz. During the following 3 years 820 long tons of ore averaging about 18 percent manganese was shipped by Goyn to the Government purchasing depot in Wenden, Ariz. Operations were suspended early in 1955 shortly before the Wenden depot was closed.

The ore occurs in a bed of reddish sandstone similar in appearance to parts of the Tertiary sediments found in the Artillery Mountains. The manganese-bearing bed crops out along the side of a shallow wash, where it is exposed for about 600 feet along the strike. It ranges from 4 to 8 feet in thickness, strikes eastward, and dips 15°–30° S. Beyond its eastern exposure the bed passes under the overlying barren sandstones. The manganiferous zone beyond the outcrop to the west either has been eroded or downthrown below the present surface by faulting. Minor folds or rolls are evident in the beds in several places along the outcrop.

The manganese minerals are largely soft, finely divided oxides disseminated rather uniformly throughout the sandstone. Parts of the bed have been enriched by numerous narrow fractures filled with supergene psilomelane and pyrolusite.

The ore was mined from shallow opencuts along the outcrop and from underground open stopes adjacent to two inclined shafts, which followed the bed down the dip to a maximum depth of about 100 feet. A double-drum gasoline hoist and scraper were used to remove the ore from the underground workings.

PILOT ROCK AREA

The first manganese ore shipped from Mohave County was mined during 1917 in the Pilot Rock area from claims then known as the Arizona Manganese group. In the 1940's, during the Second World War, these claims were called the Thompson group. In the early 1950's they were relocated under the names of the BS and Pilot Rock groups. The area borders the eastern shore of Havasu Lake on the Colorado River and lies in sec. 6, T. 12 N., R. 19 W., about 11 miles above Parker Dam and some 24 air miles south of Topock, Ariz. The claims are accessible over approximately 40 miles of winding desert road that branches south from United States Highway No. 66 about 9 miles east of Topock. The turnoff from the highway is marked "Site Six." The claims can be reached by traveling 21.6 miles on this road, thence on a left fork for 1.5 miles to the powerline road, south for 12.4 miles to a right branch, and on this branch for 4.5 miles to the southern end of the claims. The area also may be reached by boat from several boat landings on Havasu Lake above Parker Dam.

The first claims in the area were located in 1916. During the following year a few hundred tons of sorted ore was produced and transported by boat down the Colorado River to Parker, Ariz., where it was transferred to railroad cars for shipment. During the early 1940's the claims were acquired by R. H. Thompson, of Parker. Whether or not any ore was produced during this time is not known. In the early 1950's some of these older claims were relocated as the BS group by Earl Heath, of Yucca, Ariz., and 11 other claims to the northwest which constitute the main deposit were relocated as the Pilot Rock group, known as Manganese Nos. 1 to 11, by Gene De Zan, of Bakersfield, Calif. During 1955 Earl Heath shipped about 144 long tons of sorted ore averaging close to 38 percent manganese to the Government purchasing depots in Wenden, Ariz., and Deming, N. Mex. This ore was mined on the BS Extension claim. During the same year Gene De Zan shipped about 41 long tons of sorted

ore averaging 29.4 percent manganese from the Pilot Rock group to the Government depot in Deming, N. Mex. When the area was visited early in December 1955, the mines were inactive, and the camps of both Heath and De Zan were deserted.

The rocks in the region include Precambrian granites and Tertiary sandstones and basalts. The manganese deposits occur mainly in five narrow parallel veins and fracture zones that cut the basalt and the sandstones. The veins and fracture zones for the most part strike north, dip rather steeply east, and are arranged in a sort of an echelon pattern within an area several hundred feet wide and nearly a mile long. The higher grade ore occurs along the veins and fractures in lenses ranging from 2 to 6 feet in width and from 20 to several hundred feet in length. In some places lower grade material consisting of narrow seams of manganese oxide extends outward for several feet into the walls of the veins.

The chief manganese minerals are psilomelane and pyrolusite occurring in gangue of calcite, wall-rock inclusions, and iron oxides.

The principal workings in the area consist of 10 or more shallow opencuts and an inclined shaft about 60 feet deep. The opencuts followed the better ore exposed along the outcrops of the various veins. These openings range from a few feet to 12 feet in depth. The ore shipped from the BS Extension claim was mined in small open stopes adjacent to the inclined shaft.

YUCCA (SANTA FE)

The Yucca mine, known in the past as the Johnston and Jones property, is about 8 miles south of Powell, Ariz., in sec. 17, T. 15 N., R. 20 W., on land owned by the Santa Fe Pacific Railway Co., land management subsidiary of the Atchison, Topeka & Santa Fe Railway Co. The property can be reached over 7 miles of poor dirt road that branches south from United States Highway No. 66 about 6 miles east of Topock, Ariz. After leaving the highway the road follows the powerline for 3.3 miles, where a right branch leads to and terminates on the property.

In 1929 the property was optioned by the Chapin Exploration Co., which did some sampling and a small amount of exploration work, and in 1939 it was leased to Johnston and Jones, of Oatman, Ariz. In 1941 the lease was acquired by Frank Smith, of Bakersfield, Calif., who shipped a few hundred tons of sorted ore to the Fontana, Calif., plant of Kaiser Steel Corp. This ore was said to have contained 35 to 40 percent manganese. In 1948 the Yucca Manganese Mining Co. obtained a sublease from Frank Smith and mined several thousand tons of manganese-bearing material for use as a soil fertilizer. As far as known, little if any of this material was marketed and for the most part still remains in piles on the property. In 1953 Reed and Reed, of Kingman, Ariz., under a sublease from Frank Smith, shipped 107 long tons of sorted ore containing about 21 percent manganese to the Government purchasing depot in Wenden, Ariz. During the latter part of 1954 the Minerals Material Co. of Calif., under an agreement with Smith, explored the deposit by numerous drill holes. The results of this work are not available. When visited in December 1955, there was no activity in the area.

The property is about 3.5 miles east of the Colorado River near the southeast end of a chain of sharp, pointed volcanic peaks known as the Needles. The rocks in the region include granite, sandstone, tuff, and volcanic flows. The manganese deposits in the area occur as bedded deposits in sandstone and also in steeply dipping zones of shearing and faulting in volcanic rocks. The principal occurrences are in the south central part of sec. 17 about a quarter of a mile north of an old abandoned campsite.

In this area a bed of manganese-bearing sandstone crops out in places for about 550 feet along the upper part of a low ridge. The bed is composed of manganiferous lenses interlayered with lenses of barren sandstone. As exposed along the outcrop, the deposit is 4 to 7 feet thick, strikes northeast, and dips 5°–10° NW. Beyond its last surface exposure to the northeast the bed has been removed by erosion, and to the west it apparently terminates against a wide fault zone trending northwest and cutting volcanic rocks.

The outcrop of the bed had been explored in several places by shallow cuts and a small inclined adit that followed the mineralization for about 40 feet down the dip. Drill holes of unknown depth were found that indicated the deposit may have been explored in places for as much as 200 feet down the dip.

The chief manganese minerals in the bed are soft, amorphous, wadlike oxides intimately mixed with the sandy sediments.

In addition to the bedded deposit, manganese occurs in the fault zone, which limits the western extent of the manganiferous sandstone. The fault zone is 20 to 40 feet wide, dips almost vertically, and strikes N. 75° W. through volcanic rocks. The mineralized fractures range from a fraction of an inch to several inches in width. Occasional irregular masses of ore as much as 2 feet in their greater dimension occur in areas where the fractures are more numerous and closely spaced.

The principal manganese minerals in the

fault zone are psilomelane and pyrolusite. Fragments of brecciated country rock, calcite, barite, and iron oxides are the chief gangue constituents.

The south end of the zone had been explored by several shallow pits and cuts, some of which reached depths of 12 feet. More extensive opencuts had been driven several hundred feet to the northwest. The largest of these openings was nearly 100 feet long and up to 40 feet wide. This work reached a maximum depth of about 15 feet below the outcrop.

WICKIEUP QUEEN (EMERY GROUP)

This property, comprising 8 unpatented claims known as the Emery group, is about 65 miles southeast of Kingman, Ariz., in sec. 22, T. 15 N., R. 13 W. The claims are accessible over 4 miles of dirt road that branches west from State Route 93 about 6 miles south of the village of Wickieup, Ariz.

The claims were located in 1951 by the present owner, Emery Blevins, of Wickieup, Ariz. During 1954 Floyd Brown, of Wenden, Ariz., obtained a lease on the property and shipped about 49 tons of hand-sorted ore averaging 15.2 percent manganese to the Government purchasing depot in Wenden, Ariz.

Manganese mineralization occurs in two parallel fracture zones cutting Precambrian granitic rocks. The zones strike north and appear to dip steeply east. The north zone, as exposed by bulldozer stripping and a shallow opencut, ranges from 30 to 45 feet in width and can be traced for about 300 feet along the strike. The other mineralized zone, some 1,800 feet to the south, also exposed by stripping, ranges up to 200 feet in width and can be traced for approximately 250 feet along the strike.

Both zones are composed largely of equal amounts of quartz and manganiferous calcite with occasional bunches and seams of wad and pyrolusite. Most of the ore that was shipped consisted of these bunches which were selectively mined in an opencut about 50 feet long driven along a pronounced zone of shearing on the footwall of the northern deposit. Nodules of galena and other lead minerals were exposed in places along this shear zone.

The manganese content of the manganiferous calcite is very deceptive. In much of this material the manganese oxides are deposited as very thin films on the crystal cleavages in such a way as to make the calcite appear jet black, yet upon analysis it may contain only a fraction of 1 percent manganese.

CARROW PROSPECT

The Carrow prospect is a small isolated occurrence in east central Mohave County far removed from any other known manganese deposits. It is in SW¼ sec. 35, T. 24 N., R. 13 W. on deeded ranch land formerly held by Edward Carrow and now owned by R. W. Green, Kingman, Ariz. The property is accessible over a mile of dirt road that branches southeast from United States Highway No. 66 about 2.7 miles east of Valentine, Ariz.

Manganese minerals filling narrow seams are exposed in a few scattered spots in a basalt underlying a flat basinlike valley. During the Second World War shallow pits were dug to expose some of the occurrences, and several hundred pounds of ore was taken out. No further work has since been attempted. The principal exposures are found in an area about 500 feet square. The chief manganese minerals are psilomelane and pyrolusite.

BLACK DIAMOND

The Black Diamond property [12] comprises two unpatented claims in an isolated region along the eastern slope of the Virgin Mountains near the extreme northwestern corner of Mohave County. The claims lie near the east central part of unsurveyed T. 37 N., R. 16 W., about 20 air miles south of the village of Littlefield, Ariz., and about the same distance by road southeast of Mesquite, Nev. The area can be reached over a poor road that branches south from United States Highway No. 91 about halfway between the villages of Bunkerville and Mesquite, Nev.

The deposit was examined by an engineer of the Federal Bureau of Mines in 1952, and the following information is based upon the results of that examination.

The claims appear to have been located originally during the Second World War by Albert Wharton and A. E. Walker. At that time about 12 tons of ore containing 31 percent manganese was shipped to the Metals Reserve Company. In 1950 the Dixie Silica Sand Corp. of Utah operated the property a short time and shipped about 123 tons of ore averaging 27.6 percent manganese to the Columbia-Geneva Steel plant in Geneva, Utah. The claims were relocated by a group of men, who later sold their interests to Charles A. Howe, of Mesquite, Nev. Howe is said to have sold the property to the Four States Prospecting & Exploration Co., of St. George, Utah. In 1952 the claims were held by Elbert A. Blakely, Silver City, N. Mex., under a lease-option agreement from the Four States Prospecting & Exploration Co.

The deposit occurs in a steeply dipping fault zone cutting Paleozoic limestones. The zone is 30 to 70 feet wide, strikes northeast, and is exposed for about 300 feet along the strike. It

[12] Not to be confused with the Black Diamond group in the Artillery Mountains.

is composed largely of brecciated fragments of silicified limestone. Although much of this breccia contains small amounts of manganese, the best ore occurs near the central part of the zone in an irregular lenticular body that ranges from 2 to 20 feet in width and is exposed for about 140 feet. The southwest end of this body terminates rather abruptly in barren brecciated limestone. About 80 feet northeast of this point the deposit splits into two prongs separated by unmineralized limestone. Farther northeast these prongs gradually taper and fade into poorly mineralized material.

The manganese minerals, consisting of wad, pyrolusite, and psilomelane, occur in a complex pattern of fractures surrounding the brecciated fragments of the limestone. The manganese-bearing fractures range from a fraction of an inch to several inches in width. Where they are numerous and closely spaced they may coalesce and form irregular masses of high-grade ore several feet in diameter.

At the time of the investigation in June 1952, the deposit had been explored by two short adits and several opencuts; the deepest work was about 25 feet below the surface.

YAVAPAI COUNTY

Almost all of the known manganese deposits of Yavapai County have been found in a comparatively narrow strip that extends well across the southern end of the county (fig. 21).

Virtually all of the deposits occur in steeply dipping veins or brecciated zones that cut a variety of both sedimentary and igneous rocks.

The first manganese ore was produced during World War I. Since that time the intermittent production through 1954 has totaled some 10,000 tons of ore. About half of this ore averaged more than 40 percent manganese, and the other half contained approximately 18.5 percent. Nearly all of the higher grade ores were produced during World Wars I and II. All the low-grade ore was mined during 1953 and 1954 after the Government purchase depot was established at Wenden, Ariz.

Inferred reserves of ore in the county containing 35 percent or more manganese are limited to a few thousand tons. Most of this high-grade ore occurs in such small and sporadic bodies that the costs of mining and development are prohibitive except during times of extraordinarily high manganese prices. Not until 1953 was there sufficient incentive to explore the lower grade deposits requiring concentration or beneficiation. Consequently, very little is known concerning the number or potentiality of this type of occurrence. Meager exploration of one fairly large deposit indicated that there was a significant reserve tonnage containing 5 to 10 percent manganese.

HARRIS GROUP (HATTON)

This property, known originally as the Hatton group, comprises several unpatented claims near the southwestern corner of Yavapai County in sec. 12, T. 8 N., R. 9 W. The group may be reached over a side road about 1 mile long that branches west from the Aguila-Alamo road about 10 miles northwest of Aguila, Ariz. Both United States Highway No. 60–70 and the Atchison, Topeka & Santa Fe Railway pass through Aguila.

The claims were located originally in 1916 by J. Hatton and were productive during the following 2 years. The original locations evidently were allowed to lapse shortly after the end of World War I. Since that time the property has been relocated and operated intermittently by several different individuals. When the area was visited in April 1954, the group was held by J. D. Harris, of Aguila, Ariz., and work had been resumed only recently after a long period of inactivity.

According to published records,[13] the production from the property during World War I and in 1923 amounted to about 1,300 tons of ore containing 28 to 41 percent manganese. There is no record of any production after 1923. The present operators expected to start shipping ore to the Wenden stockpile in mid-1954.

Manganese mineralization on the property occurs in lenticular ore shoots in a well-defined vein cutting red sandstone. The vein strikes west, dips very steeply northward, and ranges from 1 to 6 feet in width. Its outcrop can be traced almost continuously for over 700 feet. The ore formerly mined was found in several separate bodies spaced at regular intervals along the vein over a distance of about 350 feet. Very recent work exposed ore in an area on the surface some 400 feet west of the former productive area. The work had been too limited in scope to indicate the extent of this new occurrence.

The ore minerals are pyrolusite and psilomelane occurring in a gangue composed principally of brecciated sandstone, calcite, and barite.

The underground workings were not accessible at the time of the visit in April 1954. As viewed from the surface, the old work consisted of several open stopes, one or more shafts, and a number of opencuts. The largest stope was about 60 feet long and 1.5 to 6 feet wide and was reported to be about 50 feet deep—the deepest point reached in any of the workings. The stopes were separated along the strike by

[13] Hewitt, D. F., Callaghan, Eugene, Moore, B. N., Nolan, T. B., Rubey, W. W., and Schaller, W. T., Mineral Resources of the Region Around Boulder Dam: Geol. Survey Bull. 871, 1936, p. 84.

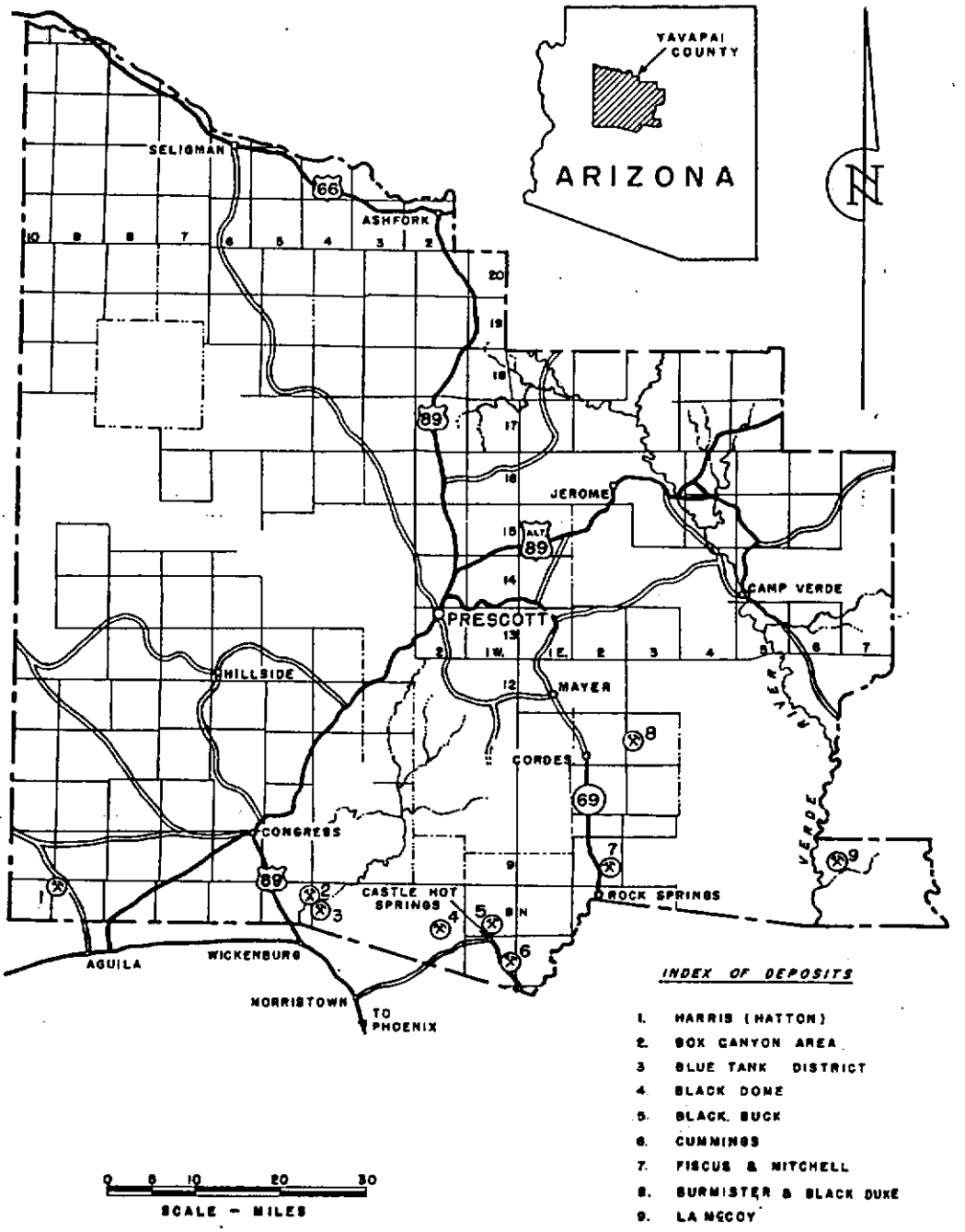

FIGURE 21.—Manganese Deposits of Yavapai County.

stretches of pinched and poorly mineralized vein matter. At the time of the visit a flatly inclined shaft had been started to connect with the lower part of the workings.

Jones,[14] who examined the mine in 1918, describes it in part as follows:

> The best ore was obtained near the surface, and the limit of commercial ore in depth as shown in the shaft is about 35 feet. The ore is screened and hand sorted in order to obtain a product said to contain 38 percent manganese. Between August 1917, when production began, and April 1918, when operations ceased, the mine produced about 600 tons of ore. It was reported that the greater part of the ore has been mined from the deposit.

Commercial ore at the time of Jones' report generally consisted of material containing 35 percent or more manganese. The present operators believe that considerable low-grade

[14] Jones, E. L., Jr., and Ransome, F. L., Deposits of Manganese Ore in Arizona: Geol. Survey Bull. 710 (*d*), 1920, p. 181.

ore, acceptable at the Wenden purchase depot, still remains in the deposit.

BOX CANYON DEPOSITS

Manganese deposits occur along the Hassayampa River near a narrow steep-walled gorge known as Box Canyon in sec. 12, T. 8 N., R. 5 W., some 8 miles by road north of Wickenburg, Ariz. The deposits may be reached over 6 miles of poor road that branches north from United States Highway No. 89 about 2 miles northwest of Wickenburg.

The first manganese claims in the area were located in 1952 by W. L. Davis, Otto Baker, and Henry M. Jones, of Wickenburg. It generally was not known at the time that the Box Canyon area in which the claims were located had previously been selected as a possible dam site and withdrawn from entry by the Bureau of Reclamation. Hence, these claim locations were not valid. However, as the deposits were some distance below the proposed dam site, the Bureau of Reclamation had not as of May 1954 interferred with the mining operations, although the operators were notified that they might be evicted at any time.

Late in 1952 the Mistake group of five claims was leased to Paul Pellegrini by W. L. Davis and Otto Baker. At about the same time a group of adjoining claims, known as the Black Top, was acquired by Lord M. Butler from W. L. Davis. Mining operations were begun on both properties in 1953, and during that year the total production from the area amounted to about 780 long tons of ore containing 16 to 34 percent manganese. The greater part of the tonnage, averaging less than 20 percent manganese, was produced by Paul Pellegrini from the Mistake claims. The ore from both properties was shipped to the Government purchasing depot at Wenden, Ariz. When the district was visited in May 1954, both properties were active, and production was continuing at the rate of several hundred tons of ore monthly.

Manganese mineralization in the area occurs along steeply dipping fractures in a volcanic breccia. The fractures range from 3 to 10 feet in width and strike northwest, and some are more or less continuous for several nundred feet along the strike. The best ore is found in disconnected lenticular bodies spaced erratically along the fracture zones.

The manganese minerals, consisting of a mixture of the common oxides, occur as irregular bunches and veinlets surrounding unreplaced fragments of the volcanic breccia. Calcite, quartz, and wall-rock inclusions are the principal gangue constituents.

At the time of the visit ore was being mined from two different fractures, one of which was at the northern end of the Mistake group and the other several hundred feet northwest on the south end of the Black Top claim. The occurrences were on opposite sides of the Hassayampa River, and both were near the top of the steep walls of the canyon. The workings on the Black Top claim consisted of several shallow opencuts and one or more adits that followed the better ore for short distances into the north wall of the canyon.

The mineralized fracture on the Mistake claim cropped out along the top of a ridge trending south on the south side of the river. The workings there were about 160 feet vertically above the river. An aerial tram was used to lower the ore down to the road at the base of the ridge. The deposit was developed by a short crosscut adit from which a drift followed the ore along the strike for about 150 feet. Several open stopes extended to various heights above the northern half of the drift. The largest stope, at the extreme north end of the drift, ranged from 15 to 30 feet in length, bulged in places to as much as 10 feet in width, and had been partly broken through to the surface. The north end of the drift from which the bulk of the ore had been produced was 30 to 40 feet below the outcrop. To the south, because of the upward slope of the hillside, the drift had reached a depth of some 85 feet below the surface. In the deeper part of the workings the veins were narrower and lower grade than those at the northern end of the deposit. Thus, it appeared that the widest veins and best ore occurred along the fracture where the workings were only a few tens of feet below the outcrop of the mineralization.

Other manganiferous exposures were found both to the southeast and northwest along the general trend of the fracture zones. Little if any exploratory work had been done on these occurrences, and their extent was not indicated. Claims to the northwest, held by B. S. Kilpatrick and Ross Fitch, were in this category, as were the locations of Otto Baker southeast of the Mistake group.

After the visit of May 1954 the area was restored to the public domain, and the Mohave Mining & Milling Co. became interested in this district. The company obtained leases covering parts of secs. 2, 11, 12, and 13, R. 5 W., and secs. 7, 17, 18, and 20, R. 4 W., both in T. 8 N. The property includes leases on Baker and Jones' claims, including Mistake Nos. 1, 2, and 3, Black Top claim, and State leases. A 1,000-ton combination heavy-media-flotation plant was constructed in the Box Canyon area, and later a sintering plant was built on the railroad about 7 miles northwest of Wickenburg.

BLUE TANK DISTRICT

BLACK ROCK GROUP

The Black Rock group comprises 6 unpatented claims in the Blue Tank mining district about 8 miles northeast of Wickenburg, Ariz. The property is in sec. 20, T. 8 N., R. 4 W., and is accessible over a side road that branches north from the main Constellation road about 3 miles northeast of Wickenburg. The side road forks some 2 miles north of the Constellation road. The right or east branch of the fork leads to and terminates at the principal workings on the property.

The claims were located in 1950 by H. A. Birchfield, of Wickenburg, but were later leased to L. W. Curry. In August 1953 Shirley and Gunther, of Sherman Oaks, Calif., purchased 1 of the claims and obtained a lease on the other 3 claims of the group. Ore shipments from the property to the Wenden purchase depot were made by H. A. Birchfield early in 1953 and were continued by both L. W. Curry and Gunther and Shirley until April 1954. The combined production of the different operators aggregated some 1,400 long tons of ore that averaged about 17 percent manganese. When the area was visited late in April 1954, the property was idle and most of the equipment had been removed.

Manganese mineralization occurs in a fracture zone trending north and cutting a coarse-grained granitic rock. The zone ranges from 8 to 18 feet in width and dips about 65° W. The outcrop was exposed along the strike for 500 feet. Appreciable quantities of manganese oxides were evident along the fracture zone in 2 separate areas some 250 feet apart. The southern mineralized area was the source of all the ore produced from the property. The northern area of mineralization appeared less promising and, though explored to some extent, had not been developed. Ore had been mined from the southern or productive part of the zone for about 125 feet along the strike and to a maximum depth of about 70 feet.

The width of minable ore evidently varied greatly in different parts of the ore body. As exposed in the north end of the opencut, the fracture zone was mineralized over a width of as much as 18 feet. However, the best ore was localized along the walls of the zone, where it occurred in irregular strands ranging from 2 to 4 feet in width. The lower grade material occupying the central part of the fracture was composed largely of fragments of unreplaced granite surrounded by seams and small masses of manganese oxides.

Pyrolusite appeared to be the chief manganese mineral. The gangue consisted largely of unreplaced wall rock, calcite, and quartz.

Most of the ore produced from the deposit was mined in an opencut. During the late phase of the operations an inclined shaft was sunk in the ore body to a depth of 80 feet. At 70 feet in the shaft, the deposit was explored by about 60 feet of lateral work. Some ore was mined in open stopes that extended upward from the underground work to the bottom of the opencut. The ore was hand-sorted, and some of the lower grade material was screened to obtain a grade of ore suitable for shipping.

According to Clifford James, the engineer who supervised the underground work, the best grade of ore was found in the upper 50 feet of the deposit.

BLIND CHILD

This property comprises 4 unpatented claims about 7 miles northeast of Wickenburg, Ariz., in the Blue Tank mining district. The group is in sec. 17, T. 8 N., R. 4 W., and can be reached over a side road that branches north from the Constellation road about 3 miles northeast of Wickenburg. About 2 miles north of the Constellation road the side road forks, the left branch leading to the property.

The claims were acquired in 1952 by J. R. Cameron, of Wickenburg, and later were leased to H. K. Cameron, also of Wickenburg, who did considerable exploration work and produced some 60 tons of ore in 1953. The ore, averaging about 24 percent manganese, was shipped to the Government purchase depot at Wenden, Ariz.

Manganese mineralization occurs on the claims in four widely spaced veins cutting volcanic rocks. The veins are 1 to 3 feet wide, strike northwest, and dip steeply southwest.

The principal manganese mineral is pyrolusite, which occurs in a gangue of unreplaced wall rock and calcite.

As exposed along the outcrops, the better mineralized parts of the veins appeared to be limited to disconnected areas seldom exceeding a few tens of feet in length. One of the most promising of the mineralized outcrops was explored by an adit that followed the vein into the hillside for about 50 feet. At the face of the adit, which was about 25 feet below the surface, a winze was sunk in the vein to a depth of 76 feet. From the bottom of the winze the vein was explored by 112 feet of drifting. According to H. K. Cameron, who did the work, virtually all the ore exposed by this exploration was found in the area lying between the adit and the surface. Only a few small scattered pods of ore were found in the upper part of the winze, and nothing approaching the grade of ore was encountered in the lower drift.

BLACK DOME

The Black Dome group comprises 4 unpatented claims about 21 miles northeast of the village of Morristown, Ariz., in sec. 26, T. 8 N., R. 2 W., of south central Yavapai County. The property can be reached over 3 miles of steep, unimproved road that branches north from the Morristown-Castle Hot Springs road at the ranch of D. C. Layton. The ranch buildings are 17.7 miles from Morristown and only a short distance north of the main road.

The claims were located in 1953 by G. H. Seebold, of Wickenburg, Ariz. Exploration of the deposit was begun late in that year after completion of 3 miles of access road. During 1954 about 74 long tons of ore averaging 17.5 percent manganese was shipped from the property to the Government purchase depot at Wenden, Ariz. When visited in January 1955, the property was idle and the equipment had been removed.

Manganese mineralization occurs on the claims along a fracture zone trending east in volcanic rocks. The zone appears to range from 100 to 200 feet in width, dips steeply south, and is exposed for approximately 1,200 feet. Although much of the zone is more or less manganiferous, the exploratory work indicated that the more highly mineralized portions of the fracture were localized in two areas some 600 feet apart. The soil and detrital material covering these areas had been removed with a bulldozer. As exposed by this work, the better mineralized material in the west exposure occurred in an irregular area about 200 feet long and up to 100 feet wide. In the other exposure the best ore appeared to occur within an area roughly 150 feet long and 30 feet wide.

The manganese minerals, consisting essentially of pyrolusite and psilomelane, occur in seams and small irregular masses surrounding brecciated fragments of the country rock. The deposit also contains large amounts of calcite, much of it dark-colored, suggesting that the manganese oxides may have been derived from the alteration of this dark-colored manganiferous calcite.

Seventy-four tons containing 17.5 percent manganese was mined largely in shallow opencuts, which appeared to follow the more highly mineralized occurrences exposed in the stripped areas. The opencuts were 3 to 5 feet wide, and the deepest was about 10 feet below the surface. The ore that was shipped appeared to have been hand-sorted largely from the material broken in the cuts. Much of this lower grade rejected material still remained in piles along the sides of the openings.

During 1954 about 23 tons of sorted ore averaging 39 percent manganese was shipped from the Black Hawk claim, owned by G. H. Seebold, about 0.5 mile southeast of the Black Dome group. The ore found on the Black Hawk claim occurs in short, high-grade lenses ranging from 6 to 18 inches in width.

BLACK BUCK

The Black Buck group consists of 16 unpatented claims a short distance north of Castle Hot Springs in sec. 34, T. 8 N., R. 1 W. The property can be reached from Morristown by traveling northeast over the improved dirt road that leads to the Castle Hot Springs hotel. About 23 miles from Morristown the road forks, the left branch leading to the Champie ranch. Some 2 miles beyond the fork on the Champie road a short right branch trending southeast terminates on the property. Morristown is the nearest available rail shipping point.

Some of the claims constituting the present group were located during World War I, and a small tonnage of sorted ore was shipped in 1917 and 1918. The claims were acquired some years later by the present owner, Mrs. Clara Cordes, of Glendale, Ariz. Late in 1952 the property was leased by Dennis Newlin and associates, of Phoenix, Ariz.

When the property was visited in April 1954, the lessees had shipped about 600 long tons of ore, averaging 21 percent manganese, to the Government purchase depot at Wenden, Ariz. Six men were employed at the time of the visit, and 15 to 20 tons of ore was being produced daily.

The ore on the property occurs in several veins or fracture zones cutting granitic rocks. The veins range from 1 to 6 feet in width, vary in strike from west to north, and dip rather steeply southwest. Some are traceable on the surface for several hundred feet, and others appear to be limited to strike lengths of less than 100 feet. The principal vein from which the bulk of the ore was produced contained a series of lenticular ore bodies spaced rather closely and extending for about 600 feet along the strike. The individual ore lenses ranged from 1 to 4 feet in width and from 10 to 75 feet in length. They were separated along both the strike and the dip by poorly mineralized vein matter.

The ore minerals, consisting of the common oxides of manganese, occur in irregular masses and in veinlets surrounding brecciated fragments of wall rock. Calcite, both white and black, is an abundant gangue constituent.

The ore was mined largely in opencuts ranging from 10 to 20 feet in depth. An inclined shaft near the southern end of the main vein followed the fracture down the dip for about 67 feet. It was reported that the mineralization

exposed in the lower half of the shaft was not of minable grade.

Operating costs, according to Dennis Newlin, amounted to about $20 per ton of ore shipped—$10 for labor, $4 for supplies, and $6 a ton for transporting the ore to the Wenden purchase depot.

CUMMINGS CLAIMS

The Cummings group, comprising 12 unpatented lode claims known as Manganese Nos. 1 to 12, is in the east half of secs. 13 and 14, T. 7 N., R. 1 W., about 7 miles southeast of Castle Hot Springs. The claims can be reached from Morristown, Ariz., over 32 miles of dirt road that passes the Castle Hot Springs resort hotel. Beyond the hotel the road follows the bed of Castle Creek for about 5 miles to a road fork, the left or north branch leading to the property. The principal workings are about 2 miles north of this road fork.

The claims were located in 1940 by R. P. Cummings, of Phoenix, Ariz. In the following year a small gravity concentrating plant was erected on the property. The mill was operated by Cummings for a short time and is reported to have produced about 10 tons of concentrates containing approximately 45 percent manganese. In 1953 Lederman brothers, of Phoenix, and H. V. Bosley, of Flagstaff, Ariz., obtained a lease from R. P. Cummings and operated the property during the latter part of 1953 and the early part of 1954. According to H. V. Bosley, about 25 tons of concentrates was produced during this period. The concentrates, reported to contain about 40 percent manganese, were shipped to the Government purchase depot at Wenden, Ariz. The property was idle when visited late in April 1954.

The deposit is a placerlike accumulation of nodules of manganese oxide occurring sporadically in the soil and detrital material along the bed of a shallow wash. The wash occupies the central part of a relatively flat, gently sloping mesa that extends southward from the foothills of the Bradshaw Mountains. The ore fragments found in the soil consist of hard psilomelane ranging from particles the size of wheat to smooth rounded nodules as large as an inch in diameter. The nodules were evident on the surface in scattered and varying amounts for a length of about 1,000 feet along the course of the wash and in some places over a width of as much as 300 feet. The manganese-bearing soil ranged from 2 to 4 feet in thickness and rested upon a rather hard cemented gravel that evidently contained little if any manganese.

In 1944 engineers of the Reconstruction Finance Corporation explored the deposit by drilling eight prospect pits spaced at irregular intervals over the area. The results of this work showed that the manganese-bearing soil averaged about 2.5 feet in thickness and 72.6 pounds of manganese oxide nodules per cubic yard. The cleaned nodules contained about 47 percent manganese. On this basis, the material averaged 34 pounds or about 1.5 long-ton units of metallic manganese per cubic yard.

The material treated in the mill was mined with a small dragline shovel from several pits along the bottom of the wash. The largest of the excavations was about 200 feet long, 10 to 20 feet wide, and 2 to 5 feet deep. The mined material was trucked about a mile to the mill, which was near a well that supplied water for the operations. The mill equipment consisted of a trommel screen, 2 small jigs, and 2 concentrating tables.

FISCUS AND MITCHELL CLAIMS

This property of 4 unpatented claims, known as the F and M group is on State Highway 69 about 3 miles north of Rock Springs, Ariz. The claims are in SE¼ sec. 27, T. 9 N., R. 2 E., and are accessible over a short side road that leaves the east side of the highway a few hundred feet north of milepost 245.

The claims were first located in 1950 by Dal Fiscus and Guy F. Mitchell, of Bumble Bee, Ariz. In 1953 the property was leased to A. J. Kelton who, while exploring the more promising mineralized exposures, shipped about 49 tons of sorted ore averging 19.6 percent manganese to the Government purchase depot at Wenden, Ariz. The property was idle when visited in mid-September 1954.

Oxides of manganese occur on the claims in small irregular masses and seams distributed erratically in a gently dipping bed of soft light-colored volcanic tuff. The bed is exposed in places along the western end of the claims, where an arroyo trending south cuts through the basalt that overlies much of the tuff. Manganese mineralization was exposed in the upper part of the tuff in 4 or more disconnected areas at intervals of 200 to 800 feet.

These mineralized areas had been explored by shallow pits and opencuts, the most extensive of which was a bulldozer trench about 500 feet long, 20 to 50 feet wide, and as much as 10 feet deep. The manganese minerals exposed in the various openings consisted largely of wad, which occurred in a diversified pattern of small seams 1 or 2 inches wide, usually separated by a foot or more of unmineralized tuff. A few of the seams were closely spaced and formed irregular bunches of ore that sometimes covered an area of several square feet. Evidently the ore shipped from the property came largely from these occurrences as exposed during the course of the exploratory work.

A similar occurrence of low-grade manganese mineralization was noted in volcanic tuff near Highway 69, some 4 miles south of the Fiscus and Mitchell claims. This had been explored by a single shallow prospect pit, but the extent of the mineralization was not indicated.

BURMISTER MINE (BLACK MAGIC)

The Burmister deposit, also known as the Black Magic, occupies part of 78 acres of deeded ranch land in SW¼ sec. 17, T. 11 N., R. 3 E., about 14 miles by road southeast of Mayer, Ariz. The property can be reached over 13 miles of a graded dirt road that branches southeast from the east side of State Highway 69 about 1 mile south of Mayer. The nearest rail shipping point is Mayer, which is the terminus of the Prescott Branch of the Atchison, Topeka & Santa Fe Railway.

The ownership of the deeded land on which the deposit occurs is divided between Cecil and Henry Burmister, of Mayer, Ariz. Title to the western part of the tract, comprising 57 acres, is held by Cecil Burmister, and the adjoining 21 acres is owned by Henry Burmister. The line dividing the two tracts passes through the east side of the deposit.

The first ore from the property was shipped in 1917. Since that time the deposit has been worked intermittently by several different operators, all of whom produced more or less ore. Although there is some difference of opinion regarding the early production from the deposit, the most authentic information indicates that from 1917 through 1942 a total of 3,215 tons of ore containing 50 to 53 percent manganese was shipped from the property. This estimate was made in 1943 by the late Frank R. Giroux, a reputable engineer and assayer of Mayer, who acted as shipping representative for the operators and the owners of the property. The mine was idle from 1942 until late in 1952, when operations were resumed by Cecil Burmister and Harry Maxwell. When the property was visited early in August 1954, approximately 270 long tons of ore had been produced by Burmister and Maxwell. About 226 tons averaging 52 percent manganese had been shipped to the Government purchase depot at Wenden, Ariz., and some 40 tons was in the ore bin.

Thus, it appears that the total production from the deposit has been approximately 3,400 tons of sorted ore averaging 50 to 53 percent manganese.

At the time of the visit two men were employed, and the average rate of production was about 15 tons of sorted ore a month.

The ore is found in small irregular bodies distributed erratically within a flat-lying bed of travertine. The travertine ranges from 1 to 10 feet in thickness and occupies the uppermost portion of a much thicker series of sandy sediments and tuffs that rest upon Precambrian rocks. Erosion has exposed the manganese-bearing bed around the southern end of a peninsula-shaped bench or mesa that separates the valleys of Ash and Sycamore Creeks. Except near the outcrop, the mineralized bed is covered with basaltic lava. The basalt overburden ranges from a few feet in thickness at the southern end of the mesa to 50 feet or more at the northern end of the explored portion of the deposit. The ore bodies occur in the travertine as disconnected masses ranging in size from those containing a few hundred pounds to some that are said to have yielded several tens of tons of high-grade ore. The best ore seldom exceeds 2 feet in thickness and is usually localized along either the top or the bottom of the gently dipping travertine. No structural trends or guides to the ore occurrences were evident.

The chief manganese mineral is psilomelane, which in general is hard and massive and readily separated from the soft travertine matrix. Opal and chalcedony are common gangue constituents.

The ore produced from the deposit was mined from numerous opencuts, adits, and shallow shafts. As shown in figure 22, these openings were scattered irregularly over an area of some 7 acres. All of the older underground workings were caved and inaccessible. Slumped and caved areas on the surface indicated that the old underground workings were much more extensive than shown by the map. They appeared to be large enough to have explored and exploited the greater part of some 250,000 square feet of the productive bed.

At the time of the visit the operators were mining ore along the northern edge of the old stoped area. This late development consisted of several hundred feet of lateral works driven within the travertine and extending in various directions from the bottom of a 25-foot vertical shaft. It was necessary to sink the shaft through some 20 feet of basalt to reach the mineralized bed. Ore encountered by the exploratory lateral work was selectively mined and sorted in small roomlike stopes. To afford working space, 4 to 6 feet of waste in addition to the ore had to be removed. A few posts sometimes were needed to support the back of the stopes. The ore-bearing bed was soft and quite readily broken with a hand pick so that little if any explosive was necessary in the stoping or drifting operations. Wheelbarrows were used to transport the broken material to the shaft, where it was hoisted to the surface

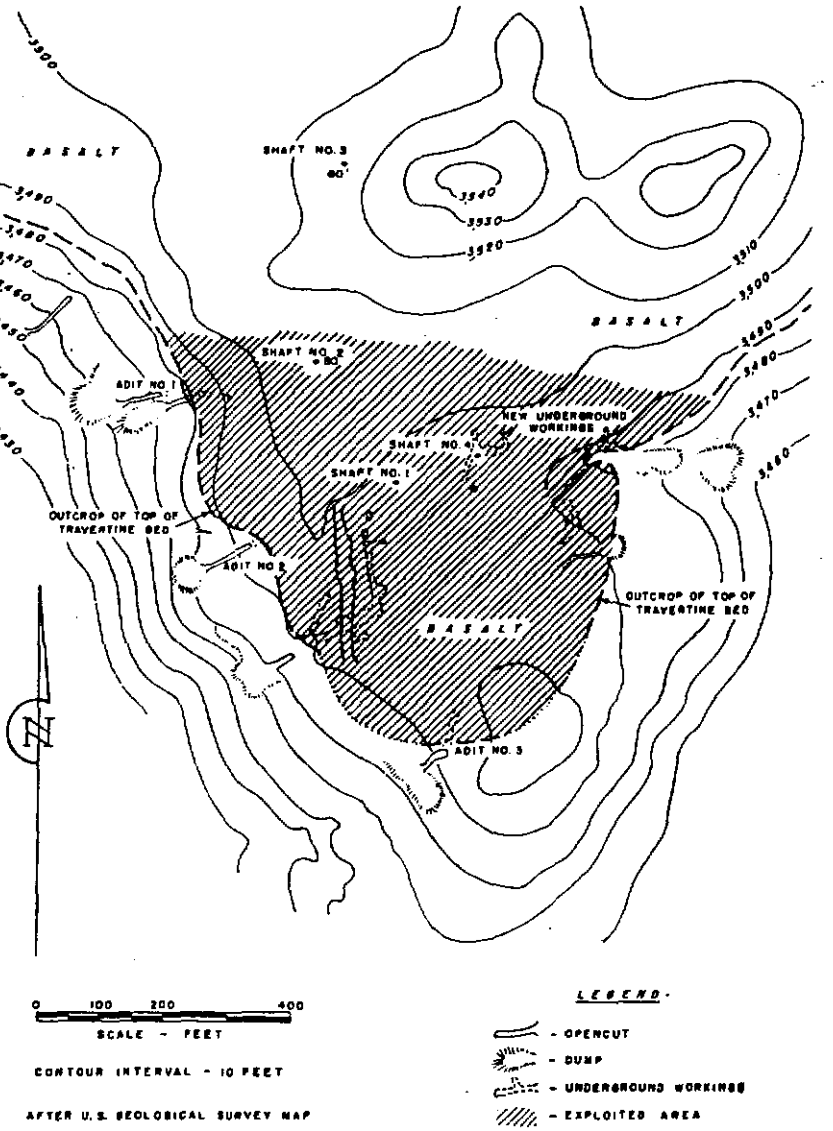

FIGURE 22.—Geologic and Topographic Map, Burmister Mine.

in a bucket. A small gasoline hoist and a timber headframe were the principal items of equipment.

BLACK DUKE (BOB ALLEN CLAIMS)

This property, formerly known as the Bob Allen claims, was relocated as the Black Duke in 1953 by Mona and Jean Bennett, of Mayer, Ariz. The claims are about a mile southwest of the Burmister deposit in NW¼ sec. 19, T. 11 N., R. 3 E.

A few carloads of ore were reportedly shipped from the property by E. V. Bunker and E. S. Rodgers during the First World War. The next output of record was about 8 tons of ore containing 36.9 percent manganese shipped by the present owners in 1953 to the Government purchase depot at Wenden, Ariz. The property was idle when visited in August 1954.

Manganese mineralization on the claims occurs in the same travertine bed in which the ore is found on the Burmister property. Much of the travertine that may have existed originally on the Black Duke claims has been removed by erosion. The portion of the favorable bed that has escaped erosion is limited to an elliptical shaped area about 600 feet long and 300 feet wide, which underlies a small, rounded lava-capped hill. The outcrop of the travertine encircles the upper part of the hill at the base of the lava. The bed was explored by many small cuts and several adits spaced irregularly along the outcrop. The principal undergound workings were in the eastern portion of the travertine. This work consisted of 2 adits on

the south side of the hill, 2 or more on the north side, and a shallow shaft that may have connected with some of the adit workings. All were caved and inaccessible at the time of the visit. The size of the dumps at the portals of the adits indicated that the undergound work was quite extensive and probably had fairly well explored what appeared to be the more promising portion of the favorable bed.

Though evidently less extensive, the ore and its mode of occurrence was very similar to that found on the Burmister property.

LA McCOY GROUP

This property, comprising three unpatented claims, is approximately in unsurveyed sec. 17, T. 9 N., R. 7 E., the Mazatzal Wilderness area of southeastern Yavapai County. It is accessible from Phoenix, via the village of Cave Creek, over 50 miles of road that ends at the Campbell ranch on the Verde River, some 15 miles above the Bartlett Dam. From the ranch the deposit can be reached over 13 miles of trail. The property also is accessible from Cordes, Ariz., over some 30 miles of poor road that passes through Bloody Basin and ends on the west side of the Verde River about 7 miles north of Campbell's ranch. The claims can be reached by this route over about 6 miles of trail.

The deposit was examined by an engineer of the Bureau of Mines in September 1941. As the property has not been worked since that time, the following description is based upon the results of that examination.

The claims were located in 1940 by James B. Ballinger and Carl Goslin. The last known address of Ballinger was Laveen, Ariz. There is no record that any manganese ore has ever been shipped from the property.

The deposit follows the top of the southern spur of McCoy Mountain, which rises some 500 feet above the north fork of Sycamore Creek. In this area manganese oxide minerals occur as seams and narrow veinlets, which fill an irregular pattern of joints and fractures in a coarse-grained granitic rock. The veinlets range from ⅛ to 3 inches in width and appear to be present within an area covering several acres. In most of the exposures the mineralized fractures are widely separated by varying amounts of granite; some of them, however, are closely spaced and form fissure zones attaining widths of several feet. Because of a cover of soil and the lack of exploration, it could not be determined if any of the occurrences were continuous for more than a few feet. The soil overlying much of the mineralized area contains fragments of hard manganese oxides ranging from small particles to nodules as large as hen's eggs. These fragments were derived from the weathering of the mineralized seams and veinlets in the granite. The manganese-bearing soil appears to average not more than a foot in thickness and contains many large boulders of granite.

The exploration work consisted essentially of a discovery pit on each of the three claims in the group. Samples taken in these openings contained 3 to 7.3 percent manganese. The mineralized material sampled ranged from 1.5 to 3 feet in width. The clean nodules of manganese oxide found in the soil contained 46 percent manganese.

YUMA COUNTY

Manganese deposits are widely distributed over the northern and central parts of Yuma County. No deposits of commercial interest are known to occur in that part of the county lying south of the Gila River.

Although small quantities of manganese ore were shipped from the county during both World Wars, the greatest period of mining activity began in 1953 after the Government purchase depot in Wenden, Ariz., was established. This depot began buying manganese ore on January 25, 1953, and after purchasing its prescribed quota of 6,000,000 long-ton units of recoverable manganese was closed on May 9, 1955. During this period over 91,200 long tons of crude ore and approximately 11,760 long tons of concentrates were shipped to the Wenden depot from 30 or more deposits in Yuma County. The crude ore averaged about 18 percent manganese and the concentrates approximately 25 percent.

The locations of the various deposits are shown in figure 23.

NORTHERN YUMA COUNTY

Several manganese deposits have been discovered along the northern boundary of Yuma County. They occur largely in the foothills bordering the valleys of the Williams and Santa Maria Rivers. The region is rather isolated and sparsely inhabited. The most accessible towns are Bouse and Wenden, Ariz. Paved highways and the Atchison, Topeka & Santa Fe Railway pass through both of these towns. Bouse is some 26 miles by road south of the deposits in the western end of the area, and Wenden is 27 to 40 road miles south of the eastern occurrences.

During 1953 and 1954 over 76,000 tons of low-grade manganese ore was mined in this part of the county. Nearly 90 percent of it was produced from the Doyle mine, which at the end of 1954 had delivered more ore to the Wenden stockpile than any other single mine in Arizona.

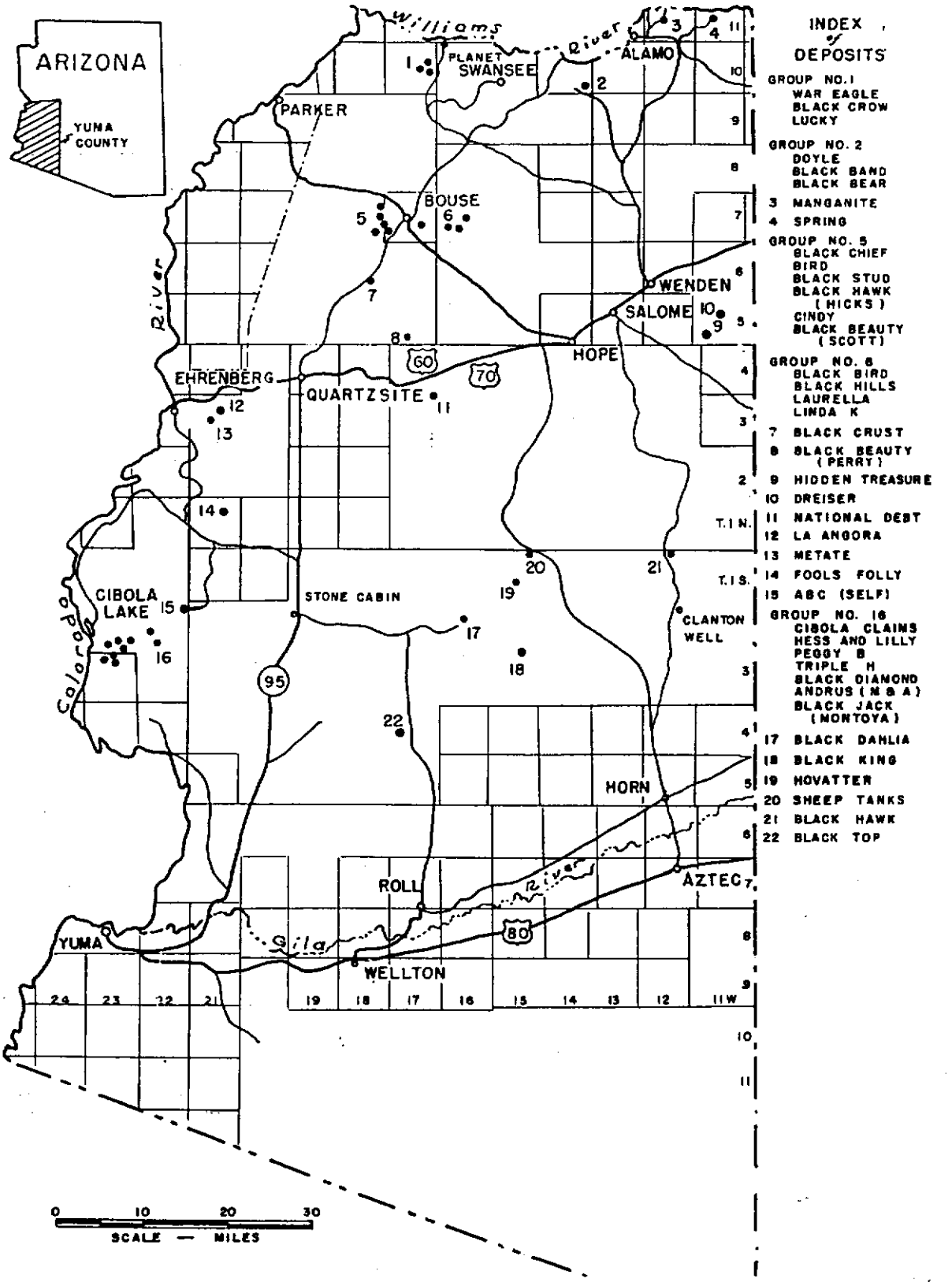

FIGURE 23.—Manganese Deposits of Yuma County.

The deposits in the area differ considerably in their mode of occurrence, some occurring in steeply dipping fracture or brecciated zones and others in flat-lying beds of limestone, sandstone, and clay.

Descriptions of the principal deposits along the north end of the county follow.

WAR EAGLE (IRON KING GROUP)

The War Eagle group of 3 unpatented claims is 26.5 miles by road north of Bouse in the east central part of T. 10 N., R. 17 W., about 3 miles southwest of the old Planet copper mine. The property is at the end of a rough 1.3-mile road that branches west from the Planet road 25.2 miles north of Bouse. From the end of the road the deposit can be reached over 300 yards of fairly steep trail.

The claims were first located during World War I and were known at that time as the Iron King group. In 1924 they were relocated as the War Eagle by S. J. Curtis, of Bouse, Ariz. The present owner is D. R. Curtis and associates, of Phoenix, Ariz.

So far as known, only 1 carload of ore has been shipped from the property; this was produced in 1916. During the late 1920's the deposit was explored further by S. J. Curtis. Since that time activity has been limited largely to the performance of the annual assessment work.

Manganese mineralization occurs in irregular bodies distributed erratically along an extensive iron-stained shear zone cutting beds of quartzite and silicified limestone. The zone strikes northwest and dips steeply northeast. It ranges from 30 to 100 feet in width and is exposed for over 1,000 feet along the strike. The ore occurs in disconnected lenses or pods generally localized in the shattered quartzite along the footwall of the shear zone. Over a distance of about 800 feet 5 such occurrences were explored by widely separated shallow cuts and by a short drift driven from the bottom of a 25-foot vertical shaft. The ore in these various openings ranged from 3 to 20 feet in width. The largest of the exposed ore bodies was about 30 feet long, and though it bulged in places to a maximum width of 20 feet, it probably averaged less than 10 feet.

The manganese minerals, principally pyrolusite, are intimately mixed with iron oxides. Most of the ore contains more iron than manganese. The other gangue constituents are brecciated fragments of quartzite, chert, barite, and calcite. Because of the intimate association of the iron and manganese minerals, the ore presents a difficult metallurgical problem and is not amenable to conventional methods of concentration.

In 1942, seven samples were taken from the various exposures by an engineer of the Bureau of Mines. The samples, representing widths of 5 to 20 feet, averaged about 15 percent manganese.

BLACK CROW GROUP

The Black Crow group of unpatented claims is about 1 air mile south of the War Eagle group.

The Bureau of Mines is not at liberty to publish a description of the deposit.

LUCKY GROUP

The Lucky group consists of several unpatented claims in the west central part of T. 10 N., R. 17 W., approximately 1.5 air miles southwest of the War Eagle deposit. The property is accessible by 2 miles of sandy road that branches northwest from the Planet road 24 miles north of Bouse, Ariz.

The claims were located in 1952 by F. E. Merrill and associates. They later were acquired and explored by F. A. Sitton, of Phoenix, Ariz. Operations were begun in 1953 and continued until mid-1954. During that time production amounted to 275 long tons of crude sorted ore averaging 20.6 percent manganese and 97 long tons of concentrates containing 33.6 percent manganese. Both products were shipped to the Wenden purchase depot. The ore from which the concentrates were recovered was treated at Bouse in a small gravity mill owned by the Linda K Mining Co.

The principal deposits were discovered near the south end of the group on the Lucky No. 2 claim. The ore, consisting of manganese and iron oxides, occurs in irregular replacement bodies in limestone. The limestone in places is 50 feet or more thick and dips about 15° SW. Its outcrop encircles the northern end of a ridge rising a few hundred feet above the surrounding washes. Brown sandstones and older crystalline rocks underlie the limestone.

Mining operations had been conducted in two mineralized outcrops on opposite sides of the ridge. An opencut on the east side exposed the mineralization for some 50 feet along the strike and for about 40 feet on the dip. The mineralized zone ranges from a few feet to 12 feet in thickness and appeared to dip slightly southwest in general conformance with the bedding of the limestone. The ore zone ends abruptly along the strike at the south end of the cut and gradually fades into the limestone a short distance north of the opening. Stripping operations farther north had uncovered small, scattered areas of manganese mineralization along the strike of the bed.

The work on the west side of the ridge explored a mineralized zone apparently associ-

ated with steep-dipping cross fractures in the limestone. The mineralized portion of the zone was about 25 feet wide, and its outcrop had been followed into the hillside by an easterly trending opencut for some 30 feet. In the face of the cut manganese minerals were exposed in seams, veinlets, and small irregular bunches surrounding masses of unreplaced altered limestone. Overburden covered the extension of the zone to the east. A few hundred tons of low-grade ore mined in the cut was piled nearby.

Approximately three-fourths of a mile northwest of this zone another steeply dipping fracture zone containing manganese minerals had been explored by a few scattered shallow pits and cuts. This zone, striking northwest, was in the old crystalline rocks. The mineralization occurred in disconnected bodies ranging from 3 to 10 feet in width; some were traceable for a few tens of feet along the strike. Overburden covered much of the area and obscured the full extent of the occurrences.

The ore minerals on the claims consist of a mixture of the common oxides associated with an abundance of iron oxides. The other principal gangue constituents are wall-rock inclusions and calcite.

DOYLE MINE (LAST RESORT)

The Doyle mine is on a group of 8 unpatented claims known as the Last Resort in NE¼ sec. 36, T. 10 N., R. 14 W., about 27 miles north of Wenden, Ariz. The property is reached from Wenden by traveling north over the Cunningham Pass-Alamo road for 16 miles to a road fork, then north on the left fork along the El Paso Natural Gas Co. pipeline road for 9.5 miles, and thence eastward on a branch road for 1.5 miles to the deposit.

The claims were located in 1928 by the Doyle brothers (Harrison and Robert N.), of Vista, Calif. No appreciable quantity of ore was produced until 1953, when the property was leased to Al Stovall and associates, of Phoenix, Ariz. After operating the mine for more than a year, Stovall relinquished the lease in the summer of 1954. Shortly thereafter, Floyd Brown, of Wenden, mined a small quantity of ore. Early in 1955 the property was leased to C. R. Maddux, of Kingman, Ariz.

Production from the deposit during 1953 and 1954 totaled 67,211 long tons of ore averaging slightly less than 16 percent manganese. This was mined in an open pit and delivered by truck to the Government purchase depot in Wenden.

When the deposit was visited in 1955, C. R. Maddux and associates had mined about 2,000 tons of ore, which was stockpiled on the property. It was reported that this ore averaged somewhat less than 15 percent manganese; arrangements were therefore being made to upgrade the material by screening, with the expectation that the screen undersize would contain enough manganese to be accepted at the Wenden purchase depot.

Both igneous and sedimentary rocks are exposed in the vicinity of the mine. Coarse-grained granitic rocks are in contact with the west central side of the ore body and extend to the southwest, where they occupy a large area. The sedimentary rocks consist principally of sandstones and conglomerates that resemble parts of the playa deposits found in the Artillery Mountains region. In general, the sediments dip slightly northeast and overlap the eastern side of the granite. The area immediately north and east of the mine workings is covered with alluvium and detrital material.

Manganese mineralization occurs in a bed within the sandy sediments. In addition to the common oxides of manganese, it contains many unreplaced inclusions of both igneous and sedimentary rocks. Some of the inclusions are angular fragments, and others are in the form of smooth, well-rounded pebbles ranging from the size of a pea to occasional boulders as much as a foot in diameter. The bed strikes about N. 30° W. and dips from a few degrees to 25° NE. The ore as mined varied greatly in thickness. Some parts of the workings were evidently as much as 50 feet below the original surface, and in other places the pit was only a few feet deep. Several faults or shear zones of various attitudes were exposed in exploited portions of the deposit. Movement had taken place along these shears, resulting in some displacement and tilting of the ore bed. The thickest and best ore appeared to be localized in those parts of the pit where the shearing was the most pronounced.

The open-pit workings covered an irregular area approximately 400 feet long and 100 to some 200 feet wide (fig. 24). The long dimension of the opening was oriented about N. 30° W. along the general strike of the ore bed. Low-grade manganese mineralization was exposed in places on the surface for about 300 feet southeast of the workings. Some of these mineralized areas had been stripped and sampled, but no mining had been attempted. A virtually barren, reddish-brown sandstone formed the northwestern face of the pit and apparently limited the extent of the ore along the strike to the northwest. An easterly trending shear, dipping moderately north, crossed the central part of the workings. The floor of the pit north of this shear was nearly flat and was a gently dipping clay gouge upon which the ore rested. The bottom of the south half of the pit was very uneven and contained unmined

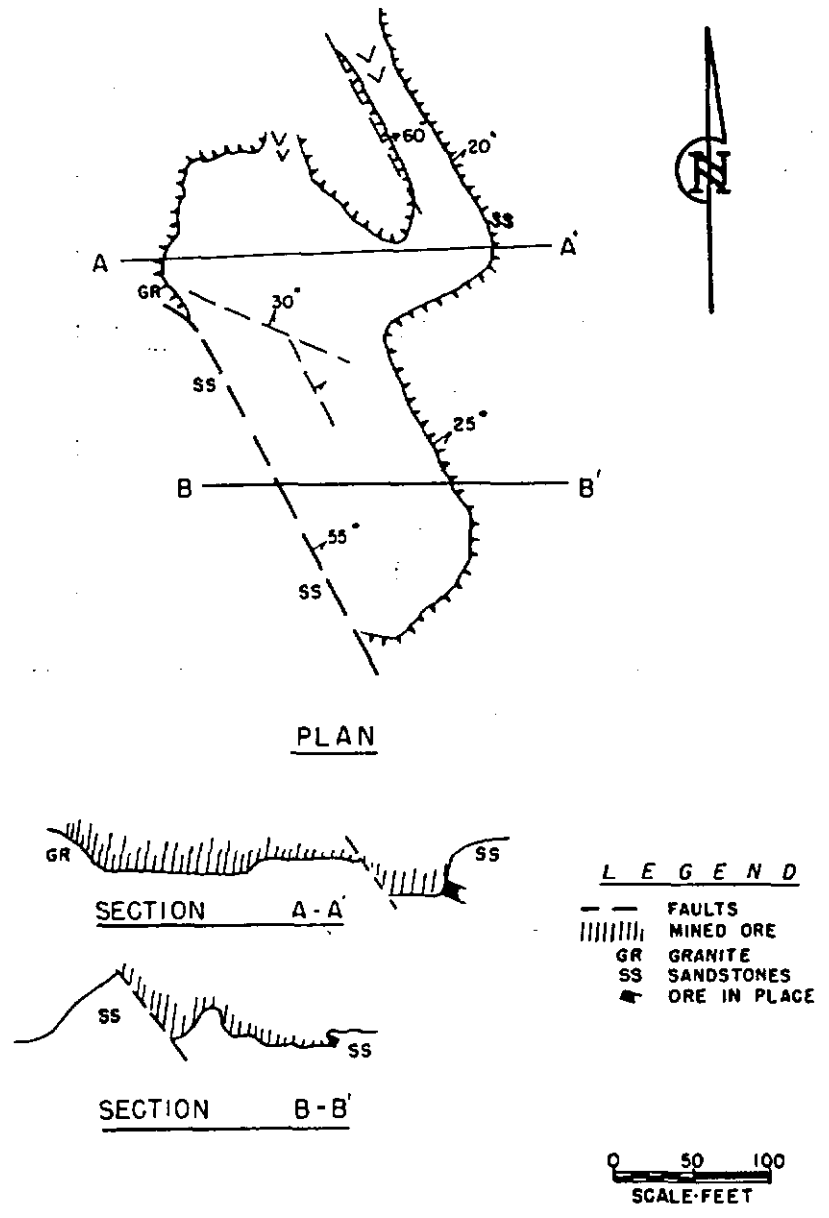

FIGURE 24.—Sketch Map, Plan and Section, Doyle Pit.

areas of poorly mineralized material. The southwestern side of the ore body was bounded by a prominent fault plane striking northwest and dipping about 50° NE. The ore lying against the hanging wall of this fault was mined in places to a depth of some 50 feet below the original surface. Farther east, away from the fault, the ore diminished in thickness. Where explored along the southeast side of the pit, it was said to have been only a few feet thick.

Another fault, strking northwest and dipping about 60° NE., was exposed along the northeast corner of the workings. Recent work east of this fault disclosed that the ore bed extended downdip out of the former exploited area. This ore was exposed in an opencut for about 180 feet along the strike. It was 12 feet thick at the face of the cut and dipped about 20° NE. A brown sandstone formed the hanging wall of the ore. The larger part of the ore stockpiled on the property at the time of the visit was mined from this deeper portion of the deposit.

The manganese minerals consisted of pyrolusite, psilomelane, and some manganite. In addition to the unreplaced rock inclusions, calcite was the most abundant gangue constituent.

The ore produced during 1953 and 1954 was mined by conventional open-pit methods. A bulldozer was used for stripping overburden and for general cleanup purposes. Blast holes

were drilled with a wagon drill and hand-held jackhammers. The broken ore was loaded into trucks by a 1-yard gasoline shovel. The drill-hole cuttings were sampled before blasting. This practice was found to be a great aid in eliminating areas of submarginal material.

BLACK BAND (MANGANESE KING GROUP)

The Black Band prospect, formerly known as the Manganese King group, is in SW¼ sec. 36, T. 10 N., R. 14 W., about one-half mile southwest of the Doyle mine. The deposit is accessible over a short side road that branches northwest from the access road leading to the Doyle mine about three-fourths mile east of the El Paso Natural Gas Co. pipeline road.

The claims were located in the late 1920's by the present owners, Harrison and Robert N. Doyle. Some of the claims are on land belonging to the State of Arizona. These are held by the Doyle brothers under a lease from the State. In 1953 the claims were leased for a short time to D. C. Roberts, and a small lot of ore containing about 10 percent manganese was shipped to the U. S. Manganese Corp. mill at Aguila. The property was inactive when visited in March 1955.

The deposit occurs in the same general series of sedimentary rocks that are found in the Doyle mine. On the Manganese King No. 1 claim manganese oxides occur in a brown conglomeratic sandstone, which crops out along the west side of a narrow, steep-walled arroyo. The bed dips about 20° W. and is exposed for some 350 feet along the strike. Mineralization in the bed occurs in three superimposed layers or bands that are separated from each other by several feet of interbedded barren sandstone. The 2 uppermost mineralized layers range from 2 to 4 feet in thickness and are a few tens of feet in length. The lower band is exposed in places for about 150 feet along the strike and ranges from 5 to 8 feet in thickness. To the north it passes under the detrital material in the bed of the arroyo. At the northern end of the band mineralization appears to grade out gradually into barren sandstone. This lower band was explored by a 15-foot adit and by a few shallow cuts. The mineralized material in the face of the adit was about 6 feet thick and was estimated to contain 10 to 15 percent manganese.

Pyrolusite was the most abundant ore mineral. The gangue consisted chiefly of sandstone and calcite.

BLACK BEAR

The Black Bear claims are about 1.5 air miles east of the Doyle mine.

The Bureau of Mines is not at liberty to publish a description of the deposit.

SPRING MINE (KAISERDOOM GROUP)

The Spring deposit is situated on a group of several unpatented claims known as the Black Bitch; they occupy portions of secs. 15 and 22, T. 11 N., R. 11 W. The property is accessible over 6.8 miles of fair road that branches northeast from the Alamo road about 33 miles north of Wenden, Ariz.

The claims originally were located in 1918 and were known at that time as the Kaiserdoom group. In 1942 they were relocated by George W. Walters, of Glendale, Ariz. During 1953 and 1954, the property was leased and worked for short periods by several different operators, including P. T. Evans, D. C. Evans, Del W. Fisher, and R. R. Hare. In mid-1954 Floyd Brown obtained a sublease, built a small washing plant, and operated the property for a short time. Early in 1955 Al Stovall, of Phoenix, Ariz., acquired the claims and built a 1,200-ton concentrating plant on the property.

Production during 1953 and 1954 totaled 1,890 long tons of sorted ore and concentrates, which averaged about 19 percent manganese. When the property was visited early in April 1955, about 120 tons of jig concentrates containing 25 percent manganese was being produced daily by Stovall.

The ore occurs in a bed of sandstone and clay in the Artillery formation. The mineralized portion of the bed is 4 to 10 feet thick, strikes northwest, and dips about 8° SW. It is manganiferous in places for well over a mile where it crops out along the lower part of the bluffs overlooking the flood plain of the Santa Maria River.

The manganese minerals, chiefly psilomelane, occur in the bed in overlapping layers and sheet-like seams interbedded with sandstone and clay. The layers are irregular lenticular bodies ranging from 1 to 12 inches in thickness.

Ore had been produced from the bed in two areas about three-quarters of a mile apart. In the workings near the northwest end of the property the bed had been mined in an opencut for about 1,300 feet along the strike and for as much as 200 feet on the dip. The work to the southeast consisted of 2 opencuts about 500 feet apart. In each of these openings the bed had been mined for 250 feet along the strike and 50 to 150 feet on the dip. In all this work 10 to 60 feet of overburden had to be stripped before the top of the ore bed could be reached and mined.

Heavy earthmoving equipment, including bulldozers, rippers, and large tractor scrapers or carryalls, were used in the later stripping and mining operations. Both the overburden and ore were soft enough that they could be broken sufficiently with rippers to permit loading with carryalls.

The concentrating plant contained a jaw crusher, a large duplex log washer, rolls, and diaphragm-type jigs. Power was furnished by diesel-driven electric generator units. Ore was delivered to a stockpile at the head of the plant by the carryalls. A bulldozer was used to push the stockpiled material into the crusher bin. After being crushed, the ore entered the log washer. The washed product was crushed to about ¼-inch size in rolls and then passed to the jigs. The jig tailings and the underflow from the log washer flowed by gravity to the tailings pond. The jig concentrates were trucked to the Government purchase depot in Wenden, Ariz.

All work on the property was terminated early in May 1955 just before the Wenden purchase depot was closed.

During Stovall's operations in 1955 estimates indicate that about 90,000 tons of ore averaging 4 to 5 percent manganese was mined and milled. The resulting concentrates aggregated 8,173 long tons averaging 25 percent manganese. Thus, about 2.27 units of manganese was recovered per ton milled.

The deposit does not appear to be exhausted and no doubt still contains substantial quantities of material similar in grade to that mined. However, the parts of the ore bed that can be cheaply mined by open-pit workings have been largely exploited. In the face of the present openings the ore is covered with 40 to 60 feet of overburden. At no great distance farther down the dip the thickness of the overburden increases so rapidly that the cost of stripping soon would become prohibitive.

MANGANITE

The Manganite deposit is on State land in NW¼ sec. 16, T. 11 N., R. 12 W., about 1 mile south of the Santa Maria River. The property can be reached from Wenden by traveling north on the Alamo road for 37 miles to a northeast branch marked Black Diamond crossing, north on this branch for 1.2 miles, and thence east 2.4 miles to the deposit.

The property is held by E. W. Tate, of Yucca, Ariz., under a lease from the State of Arizona. The deposit was explored to a limited extent in 1953, and a small amount of low-grade ore was shipped at the time to the Wenden depot.

Manganese mineralization on the property occurs in a bed of brown sandstone in the Artillery formation. The sandstone strikes westward and dips about 15° S. The mineralized portion of the bed is composed of manganese-bearing layers interbedded with barren sandstone in a zone 6 to 12 feet thick. The manganiferous layers range from a fraction of an inch to a foot or more in thickness. The zone crops out in an arc along the north end and west side of a low hill sloping gently south. As measured along the strike, the outcrop is about 450 feet long and is exposed in places on the dip for approximately the same distance before it passes under a thick series of overlying sediments. A sill-like body of basalt underlies parts of the mineralized bed. The east end of the zone terminates abruptly against a cross fault trending north. Basalt occupies the area immediately east of the fault. Beyond the outcrop to the west the upper part of the mineralized bed has been eroded.

The manganese minerals are pyrolusite and psilomelane occurring in a gangue composed essentially of sandstone.

The exploratory work consisted of a few shallow opencuts and some stripping along parts of the outcrop.

MAGNESITE

The Magnesite deposit was inadvertently overlooked when the area was visited in May 1955. The property is on State land in sec. 16, T. 11 N., R. 12 W., and is said to be held by Warren Rodgers under a lease from the State. During 1953 and 1954 it was operated by L. W. Smith, of Aguila, Ariz., who shipped over 900 tons of ore averaging approximately 22 percent manganese to the Wenden depot.

BOUSE (PLOMOSA) DISTRICT

Manganese deposits occur near Bouse, north central Yuma County, in two areas, one a few miles west of Bouse and the other east of the town. The western deposits are in a belt that follows the foothills north along the eastern flank of the Plomosa Mountains. The other belt of mineralization first appears about 1.5 miles east of town and extends east along the southern side of the Bouse Hills for several miles.

The ore in the deposits along the Plomosa Mountains occurs largely in comparatively small bodies of manganese oxides, which follow narrow fractures in lava flows, and in the underlying sedimentary and igneous rocks. The eastern belt in general is characterized by larger areas of low-grade mineralization scattered along a series of broad irregular zones of fracturing in volcanic rocks.

Though occasional small lots of ore were shipped during both World Wars, the bulk of the ore produced in these areas was mined in 1953 and 1954. Nearly all of this material was concentrated in two mills erected on the outskirts of Bouse. The largest of these mills, and the first of its kind built in Arizona, was a heavy-media separation plant of 250 tons daily capacity. This plant was constructed in 1953

by the Manganese Co. of Arizona and after operating for about a year was dismantled in the summer of 1954. During this same period the Linda K Mining Co. operated a small concentrator, using jigs and tables. In the latter part of 1954 this mill was moved to the Trigo Mountains manganese district in west central Yuma County.

The actual tonnage and grade of the ore treated in the mills is not known. Estimates indicate that as much as 35,000 tons may have been milled during 1953 and 1954. The greater part of this tonnage was treated in the heavy-media plant. The concentrates produced in both mills totaled 3,052 long tons averaging 23.0 percent manganese. These were shipped to the Government purchase depot at Wenden, Ariz. In addition to the concentrates, about 800 tons of sorted ore containing 17 to 36 percent manganese, was mined in the district during 1953 and 1954.

Descriptions of the individual deposits in the vicinity of Bouse follow.

BLACK BIRD

The Black Bird group is about 1.5 miles directly east of Bouse and comprises 8 unpatented claims covering parts of secs. 24 and 25, T. 7 N., R. 17 W. The property is accessible over 2 miles of dirt road that branches northeast from State Highway 72 at Bouse.

The claims were located a number of years ago by the present owner, J. C. Townsend, of Bouse. Active development of the manganese deposit was begun late in 1952. The first ore was shipped by Townsend early in 1953. Later that year the property was leased and operated by the Manganese Co. of Arizona until mid-1954. During that time, it is estimated that 20,000 to 30,000 tons of low-grade ore was mined. Nearly all of this tonnage was treated in the heavy-media plant owned by the lessee.

Production from the property has totaled 2,815 long tons of concentrate, averaging 22.2 percent manganese, and about 670 tons of sorted ore, averaging close to 17 percent manganese. The ore and concentrates were shipped to the Government purchase depot at Wenden. Information concerning the average grade of the ore treated in the plant is not available, nor is the percentage of manganese in the material recovered by the heavy-media process known.

Manganese mineralization on the property occurs along an irregular fracture zone in an andesitic lava. The zone strikes about N. 70° W., dips steeply southward, and is exposed some 1,100 feet on the surface. The mineralized parts of the zone range from 10 to 30 feet in width.

Ore had been mined from two areas, one of which is in the western end of the zone and the other about 350 feet to the east. Nearly all of the production came from the western area, where the ore was mined in an opencut that followed the footwall of the zone for about 550 feet. The cut ranged from 12 to 30 feet in width and averaged about 25 feet in depth. In the eastern area some ore had been produced from shallow cuts and pits scattered over an irregular area about 200 feet long. The part of the zone that separated the two exploited areas had been explored by several trenches and pits, but no appreciable quantity of ore had been mined from this part of the fracture.

The chief manganese minerals were manganite, pyrolusite, and psilomelane. Calcite and brecciated fragments of lava were the principal gangue constituents.

The manganese minerals occurred in a network of seams, veinlets, and irregular bunches deposited around fragments of unreplaced lava. In many places the best ore was localized along the footwall of the fracture from which it appeared to grade outward into the poorly defined hanging-wall portion of the zone.

In the large opencut the ore evidently had been broken in benches and loaded from the floor of the cut into trucks with a small gasoline-powered shovel. The blast holes were drilled with a wagon drill. Compressed air was supplied by a portable gasoline-driven compressor. Two inclined opencuts extending into the bottom of the pit served as passageways for the entrance and exit of the trucks. The ore was hauled directly to the mill, a distance of about a mile.

BLACK HILLS GROUP

This group of 8 unpatented claims is about 3 miles east of the Black Bird deposit in the central part of unsurveyed T. 7 N., R. 16 W. The property is accessible from Bouse by traveling east about 5 miles on a fair road that follows a wash along the southern side of the Bouse Hills.

The claims were located early in 1954 by the present owners, John and James C. Townsend, of Bouse, Ariz. When the area was visited in January 1955, all the work performed on the property had been of an exploratory nature and only one small lot of ore had been shipped.

Manganese mineralization occurs on the claims in several parallel brecciated zones cutting volcanic rocks. The zones strike northwest and appear to dip steeply southwest. They crop out where they cross the northern slopes of an eastward-trending chain of low hills. The more promising outcrops in two of the larger mineralized zones had been partly explored by stripping and shallow opencuts. Stripping with a bulldozer at the western end of the group had

exposed an irregular mineralized area approximately 500 feet long and 250 feet wide. Overburden surrounded most of the stripped area, so it could not be determined whether or not the work had disclosed the full extent of the mineralization. Within the stripped area manganese oxide minerals occurred in innumerable seams and veinlets surrounding unreplaced fragments and masses of brecciated country rock. The seams and veinlets ranged in width from the thickness of a knife blade to as much as 6 inches. The wider veinlets often were persistent for several feet and usually were oriented in a northwest direction more or less parallel to the strike of the brecciated zone. The amount of manganese in the area varied greatly from place to place. In some parts of the zone the mineralized fractures were numerous and closely spaced, forming masses of higher grade material several feet in width. In other parts the fractures were less numerous and separated by several feet of unreplaced lava.

In the stripped area cuts and trenches up to 8 feet deep had explored some of the more highly mineralized parts of the zone. A trial shipment (5.7 tons) of the material broken in some of these openings was shipped to the Government purchase depot at Wenden, Ariz.; the lot averaged 11.1 percent manganese.

Approximately half a mile farther east manganese mineralization was exposed in the outcrop of another brecciated zone striking N. 50° W. Scattered and varying amounts of manganese minerals were evident in the outcrop over an area about 250 feet long and 100 feet wide. The possible extension of the zone to the northwest was obscured by overburden. The mineralization in this area was similar to that of the west zone. The deposit had been explored by several shallow cuts and pits. So far as known, no ore had been shipped from this occurrence.

The ore minerals in both zones are the common manganese oxides, pyrolusite predominating. Calcite, gypsum, and limonite are the principal gangue minerals.

LAURELLA CLAIMS

The Laurella group of 3 unpatented claims is 5.5 road miles east of Bouse and adjoins the northeast end of the Black Hills group. The property is accessible from Bouse by the same road that serves the Black Hills group.

The claims were located in April 1954 by the present owners, V. S. Townsend, of Bouse, Ariz., and O. R. Reed, of Inglewood, Calif. Later that year a few tens of tons of sorted ore was mined from the central claim of the group. When the claims were visited in January 1955, three men were employed in further exploring the deposit.

Manganese mineralization occurs in a brecciated zone similar in strike and character to such zones found farther west on the Black Hills group. Two mineralized areas, separated by about 400 feet of alluvium overburden, were exposed along the outcrop of the zone. In the northern outcrop rather widely spaced seams and fractures filled with manganese oxide minerals were exposed within an area approximately 100 feet long and 50 feet wide. Some of the wider fractures locally reached widths of as much as 18 inches and were persistent along the strike of the zone for 20 feet or more. These had been selectively mined to depths of as much as 10 feet and were the source of the ore produced in 1954.

The southeast deposit cropped out along the top of a low ridge. The mineralized part of the outcrop was exposed for about 150 feet along the strike to a width of 60 feet. Both ends of the zone beyond this area were covered with overburden. The manganese-bearing seams and veinlets in the exposure coalesced in places, forming irregular scattered masses of ore several feet long.

At the time of the visit the operators, V. S. Townsend and associates, had just started an opencut, which when completed would crosscut a promising portion of the southern exposure. The cut had been driven into the deposit about 12 feet and was 6 feet deep. Approximately 20 tons of ore, estimated to contain 10 to 15 percent manganese, had been recovered from the opening. The operators planned to concentrate the ore from the deposit on jigs and tables in a small mill recently built a short distance northeast of Bouse.

LINDA K

This group, also known as the Mildred or Hart property, comprises several unpatented claims in the north central part of unsurveyed T. 7 N., R. 16 W., about 7 miles by road east of Bouse. The property can be reached from the Laurella deposit by traveling east-northeast about 2 miles on a fair road.

The claims were originally located in 1918 by J. N. Dobbins, who produced a small amount of high-grade ore during the year. Soon after the close of World War I, the locations were allowed to lapse. The next owner of record was John R. Hart, of Los Angeles, Calif., who so far as known still holds title to the claims. In 1953 the Linda K Mining Co., of Bouse, operated the property under a lease-option agreement until the spring of 1954. During this period estimates indicate that 1,500 to 2,000 tons of ore was mined and milled in a 100-ton concentrator a short distance southwest of Bouse. The resulting concentrates, amounting to 238 long tons and averaging 32.3 percent manganese, were shipped to the

Government purchase depot at Wenden, Ariz. The property was idle when visited in January 1955.

Manganese mineralization on the claims occurs along two fracture zones cutting volcanic rocks. The wider zone strikes N. 50° W. and dips steeply southwest. The other fracture bears about N. 60° E., dips moderately northwest, and evidently intersects the wider zone. Most of the ore produced was mined in the immediate vicinity of this apparent intersection. Seams and veinlets of manganese oxide minerals were exposed in this area for about 150 feet along the strike of the wide zone and to a maximum width of approximately 100 feet. Any extension of the mineralization farther southeast was hidden by overburden. The ore produced from the area was mined largely in an opencut about 100 feet long that followed the northeast fracture to the point where it crossed the wider zone. The cut ranged from 10 to 20 feet in width and reached a depth of about 25 feet below the higher parts of the outcrop. North of the intersection both fractures had been explored by scattered shallow openings. Apparently, no appreciable amount of ore had been produced from these openings.

The ore shipped during the First World War was mined from the northeast fracture in an area some 1,500 feet southwest of the recent work.

The old caved workings indicated that this early production came from narrow lenticular strands of ore that were localized along well-defined shears within the zone. The ore had been mined from several opencuts that extended along the strike of the fracture for about 80 feet. Few of the cuts exceeded 3 feet in width, but some reached depths of about 20 feet. Strands of high-grade manganese oxide minerals up to 4 inches wide were evident in the pillars separating the opencuts.

Pyrolusite and psilomelane were the principal ore minerals occurring on the property, and calcite and wall-rock inclusions were the chief gangue constituents.

BLACK CHIEF

The Black Chief property of six unpatented claims is near the southern end of the manganese-bearing belt that extends along the east side of the Plomosa Mountains. The claims are about 5 miles by road directly west of Bouse approximately in unsurveyed sec. 24, T. 7 N., R. 18 W. They are accessible over a fair dirt road that branches west from State Highway 95 about 1 mile southwest of Bouse.

The claims were located during the Second World War, and a small amount of high-grade ore was shipped at that time. Some years later the group was relocated by the present owner, J. C. Townsend, of Bouse. During 1953 it was operated under a lease-option agreement by the Manganese Corp. of Arizona, and about 2,000 tons of ore was mined and treated in the company's heavy-media plant near Bouse. The bulk of the concentrates recovered in the plant contained too much iron to meet stockpile specifications and therefore had not been shipped at the time of the visit. Records concerning the grade of the ore and the recovery obtained in the mill were not available. The property was idle when visited in January 1955.

The ore occurs along a steeply dipping vein trending northeast in the older metamorphic rocks. The productive part of the vein ranges from 2 to 6 feet in width and crops out along the crest of a hill for about 300 feet.

The manganese minerals—the common oxides—occur in lenticular masses and strands deposited in an irregular pattern within the brecciated vein matter. Iron oxides and calcite are the principal gangue minerals.

The deposit was developed and mined from an adit, which followed the vein for about 250 feet and reached a maximum depth of approximately 60 feet below the higher parts of the vein outcrop. An open stope about 100 feet long extended to the surface from the southwest end of the adit workings. Although much of the underground work was inaccessible, most of the wider and higher grade parts of the vein appeared to have been mined in the area lying between the surface and the adit level.

BLACK CRUST

The Black Crust group, including 1 claim known as the Rincanada, comprises 10 unpatented claims along the east side of the Plomosa Mountains in sec. 31, T. 6 N., R. 17 W. State Route 95 crosses the central part of the group about 9 miles southwest of Bouse, Ariz.

The claims were located in 1942 by C. L. Terry, of Bouse. In 1953 they were acquired by Walter S. Wilson and H. A. Severinghaus, of Phoenix, Ariz. During the early part of 1953 about 67 tons of sorted ore containing 25 percent manganese was produced from the Rincanada claim. Somewhat later the property was leased and further explored by the Manganese Corp. of Arizona. No work was in progress when the area was visited in January 1955.

Two different types of deposits have been found on the property. Manganese mineralization on the Rincanada claim occurs in steeply dipping irregular fracture zones in volcanic agglomerate. The fractures strike about N. 30° W. and range from 2 to 6 feet in width. The principal mineralized zone was exposed by a continuous opencut for about 350 feet along the strike. The cut ranged from 2 to 6

feet in width and from 2 to 8 feet in depth. The ore produced in 1953 was sorted from the manganiferous vein matter broken in this opening. About 135 feet east of this cut a similar fracture had been explored by a shallow cut for about 75 feet along the strike. In places the agglomerate separating the fractures contained minor amounts of manganese minerals.

The other deposit, on the Black Crust No. 1 claim, consists of flat manganese-bearing layers interstratified with beds of unconsolidated detrital material. The detritus occupies part of a broad alluvial fan composed of sand, gravel, and fragments of many different kinds of rocks. The manganiferous layers range from a few inches to as much as a foot in thickness and are composed of detrital material that has been impregnated and more or less replaced by manganese oxide minerals. From 1 to several feet of barren detritus separates the mineralized strata.

This deposit had been explored by some 15 pits and several trenches that covered a flat, gently sloping area roughly 500 feet square. The openings were spaced at intervals of 50 to 100 feet and ranged from 4 to 8 feet in depth. As many as 3 or 4 superimposed mineralized layers were exposed in the sides of some of the pits, while in others only 1 thin layer was exposed. The exploratory work indicated that the manganese-bearing strata were most abundant in a zone about 4 feet thick that covered an area approximately 300 feet long and 200 feet wide. Parts of the explored area were covered with several feet of overburden. In other parts the manganiferous material was exposed on the surface.

The principal manganese mineral was pyrolusite occurring in a gangue of unreplaced rock fragments, calcite, barite, and gypsum.

Samples indicated that the mineralized layers contained 12 to 15 percent manganese. Grab samples taken from all the material, including the barren detritus broken in several of the more representative pits, contained 3.4 percent manganese.

BLACK STUD

The Black Stud claim, owned by J. F. Hicks, is about half a mile southwest of the Black Hawk group in sec. 18, T. 7 N., R. 17 W. The property is accessible over a branch road that leaves the access road to the Black Hawk group about 4 miles from Bouse, Ariz. The deposit was worked during the latter part of 1953 by J. F. Hicks, who shipped about 16 tons of sorted ore containing 25 percent manganese to the Wenden purchase depot.

The ore occurs in small lenses along a fracture dipping steeply north in volcanic rocks. The lenses range from 10 to 20 feet in length and seldom exceed a foot in width. The ore was mined from an opencut in one of the larger lenses.

The manganese minerals are chiefly pyrolusite and psilomelane. Calcite and iron oxides are the principal gangue minerals.

BLACK BEAUTY CLAIMS

The Black Beauty Nos. 1 and 2 groups are near the north end of the Plomosa Mountains in sec. 8, T. 7 N., R. 17 W. They may be reached by traveling northwest about 4 miles on a fair dirt road that leaves State Highway 95 one-half mile west of Bouse, Ariz.

The claims were located early in 1954 by Foster Scott, of Bouse, who produced about 18 tons of hand-sorted ore averaging 36.7 percent manganese during the remainder of the year. When the area was visited in January 1955, three men were employed, and ore was being mined for shipment to the Government stockpile at Wenden, Ariz.

The ore occurs in lenticular bodies along irregular fractures cutting volcanic rocks. The wider fractures range from 2 to 5 feet in width, strike northwest, and dip steeply northeast. The principal workings were on the No. 1 claim, where the vein was exposed in shallow opencuts and pits for about 150 feet along the strike. Two ore shoots were exposed in the workings, the largest about 30 feet in length. The highest grade ore occurred along the footwall of the fracture in irregular bodies up to 1.5 feet thick. In places lower grade material extended outward for a few feet into the hanging-wall portion of the fracturing.

Pyrolusite and psilomelane were the most abundant manganese minerals. The gangue consisted of wall-rock fragments, calcite, and barite. The latter mineral occurred in places along the fracture in veinlets as much as 6 inches wide.

Other Claims

Other claims in the neighborhood, located by Foster Scott, included the Lucky Jack, Desert, Blunder, and Gladys. These were largely unexplored prospects in different parts of the district south of the Black Beauty group.

On the Lucky Jack claim a discovery pit had been sunk in an area of widely spaced stringers of manganiferous calcite in a coarse-grained granitic rock.

Mineralization on the Desert and Blunder claims occurs in narrow seams of manganese oxides cutting lava flows.

The Gladys deposit consisted of veinlets and small irregular masses of manganese oxides occurring in fractured limestone. Only a small

mineralized area was exposed, and the extent of the occurrence could not be determined.

BIRD GROUP

The Bird group of 18 unpatented claims is in sec. 19, T. 7 N., R. 17 W., about 4 air miles directly west of Bouse, Ariz. The claims cover a large part of a chain of low, iron-stained hills that overlook the broad valley of Bouse Wash. The area is accessible over 3.5 miles of a fair dirt road that branches west from State Highway 95 about 1 mile southwest of Bouse.

The claims were located in 1942 by the present owner, C. L. Terry, of Bouse, Ariz. They were leased in 1953 to N. D. Hightower, who explored some of the more promising outcrops and made several trial shipments of low-grade ore to the Government purchase depot in Wenden, Ariz. No work was in progress when the property was visited in January 1955.

Manganese minerals accompanied by an abundance of iron oxides occur on the property in irregular masses along brecciated zones in volcanic rocks. The zones strike northwest and appear to dip rather steeply northeast. Several such zones containing areas of manganiferous iron oxides crop out in widely separated parts of the property.

Two of the largest outcrops were on the northern slopes of a hillside near the north end of the property. In this area 2 zones some 350 feet apart had been explored by a few shallow openings. On the east zone an opencut driven across the strike exposed a manganese-bearing area about 70 feet wide. Overburden surrounded the cut, so the length and shape of the mineralized area was not disclosed. A pit north of the cut indicated that the mineralization extended for at least 50 feet along the strike. The western mineralized zone, as shown in two opencuts, was about 30 feet wide and was exposed along the strike for 35 feet before it passed under cover.

The manganese minerals, consisting essentially of the soft oxides, occur in a gangue composed almost entirely of specular hematite.

The material shipped to the Wenden stockpile by N. D. Hightower aggregated about 100 tons averaging 5 percent manganese. A large grab sample, taken by the writer from broken material in the eastern opencut, contained 6.9 percent manganese and 39.8 percent iron.

CINDY

The Cindy group of 2 unpatented claims is in the western part of sec. 19, T. 7 N., R. 17 W., about 4.5 miles directly west of Bouse, Ariz. The deposit can be reached by several hundred yards of a steep road that branches north from the main road about half a mile west of the Bird deposit.

The claims were located in 1953 by John Fornis, of New York City, N. Y. Later that year they were leased to William B. Tenny, who shipped 144 tons of sorted ore averaging about 25 percent manganese to the Government purchase depot in Wenden.

The deposit occurs along a bedding-plane fracture in limestone. The limestone strikes N. 50° W. and dips about 20° SW. The ore body was approximately 100 feet long and 1 to 3 feet thick and was mined in an opencut for about 40 feet on the dip.

The chief manganese minerals were psilomelane and pyrolusite occurring in a gangue of silicified limestone and calcite.

Apparently, most of the better ore in the deposit had been exhausted.

BLACK HAWK

The Black Hawk group of 3 unpatented claims is in sec. 18, T. 7 N., R. 17 W., about 4 air miles west of Bouse. The property is accessible by 3.5 miles of fair road that branches west from the old Parker road about 1.5 miles north of Bouse.

The claims were acquired and first worked by J. F. Hicks in 1954, who produced during that year about 50 tons of sorted ore containing 20 to 25 percent manganese. In January 1955 three men were mining ore for shipment to the Government purchase depot in Wenden.

Manganese mineralization on the claims occurs in three parallel veins cutting lava flows. The veins are 50 to 250 feet apart, strike north, and dip steeply east.

Bulldozer cuts on the east vein exposed numerous thin veinlets of manganese in a brecciated area about 100 feet long and up to 10 feet wide. The veinlets ranged from 1 to 2 inches in width and were so widely spaced that no further work had been attempted in this area.

About 250 feet northwest of the east vein a mineralized outcrop had been explored by several cuts and a shallow inclined shaft. Some ore evidently had been mined in this area from small masses and narrow strands that were localized along the walls of the vein.

The work on the west vein was limited to an opencut about 75 feet long and 15 feet deep. Two lenses of fairly high-grade ore were exposed along the bottom of the cut. The lenses were about 20 feet long and 6 to 18 inches wide.

The principal manganese minerals were pyrolusite and psilomelane, and the gangue consisted chiefly of wall-rock inclusions, calcite, and iron oxides.

BLACK BEAUTY (PERRY) [15]

The Black Beauty group of eight unpatented claims, owned by Raymond Perry, of Salome, Ariz., is near the south end of the Plomosa Mountains in sec. 34, T. 5 N., R. 17 W. The property is accessible over 6 miles of dirt road that branches north from United States Highway No. 60–70 at Ramsey Station, about 22 miles west of Salome, Ariz.

The claims were located in 1942 by Raymond Perry. No ore was produced until 1953; at the end of 1954 about 418 tons of ore had been shipped to the Government purchase depot in Wenden, Ariz. Of this, 350 tons averaging 17 percent manganese was shipped by Perry, and 68 tons averaging 12.8 percent manganese was produced by lessees. Late in 1954 Perry and associates built a small screening plant on the property. The plant consisted of a jaw crusher, rolls, and an inclined stationary screen with ¼-inch openings. The material passing through the screen was trucked some 14 miles to a small mill, where it was concentrated in jigs. The screen oversize was rejected as waste. When the property was visited early in 1955, about 10 tons of concentrates containing nearly 39 percent manganese had been produced in this manner.

Manganese mineralization occurs on the property in several parallel veins that occupy a shear zone in volcanic rocks. The veins strike north and dip steeply east. Near the north end of the claims, 5 or more rather widely spaced veins are exposed in an area about 500 feet wide and 600 feet long. They occur in an overlapping or echelon pattern and range from a few tens of feet to 100 feet in length. Approximately 0.5 mile southeast of this area is a similar but much smaller mineralized area.

The ore minerals, largely pyrolusite and psilomelane, occur along the veins in strands and irregular masses ranging from a few inches to several feet in width. In the largest and most productive vein the mineralization was exposed more or less continuously for some 80 feet along the strike. In some areas the wall rocks of the veins were impregnated with seams and stringers of manganese minerals, forming irregular pods of low-grade material up to 12 feet wide.

The workings were limited to a number of shallow opencuts. The largest opening was a cut about 50 feet long and 6 to 12 feet wide, which followed the principal vein into the hillside. A maximum depth of some 20 feet below the outcrop had been reached in this work.

[15] This property is not to be confused with another Black Beauty group in Yuma County near the north end of the Plomosa Mountains and owned by Foster Scott, of Bouse, Ariz.

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CENTRAL YUMA COUNTY

TRIGO DISTRICT

Many of the manganese deposits of west central Yuma County occur in the Trigo Mountains, a rugged, arid desert range bordering the Colorado River Valley about midway between Yuma and Ehrenburg, Ariz. The region is isolated and sparsely inhabited. Cibola, a small farming community, is the nearest settlement; it lies a few miles west of the central part of the range. The area is accessible from the north over some 45 miles of winding desert road that leaves United States Highway No. 60–70 about 2 miles east of Ehrenburg. The district also may be reached over a road that branches west from State Highway 95 about 21 miles south of Quartzsite, Ariz.

The Trigo Mountains trend northeast and are about 30 miles long and 5 to 12 miles wide. They reach a maximum altitude of some 3,000 feet above sea level and are characterized by a series of steep, parallel ridges, most of which are separated by narrow, sandy washes.

The range is composed largely of Tertiary volcanic rocks. Only relatively small areas of older underlying schistose and granitic rocks are exposed in the region of the manganese deposits. Nearly all of the known manganese occurrences have been found in the central portion of the range directly east and southeast of Jim's Landing on Cibola Lake (fig. 25). The deposits, all of similar type, consist of lenticular bodies of manganese oxides occurring sporadically in veins and brecciated zones that traverse the volcanic flow rocks. The mineralized zones in general strike north and dip slightly to almost vertically. The individual ore bodies developed to date range from 25 to 150 feet in length and may swell in places to as much as 10 feet in width, but the shipping ore usually averages less than 4 feet.

The manganese minerals, consisting essentially of pyrolusite with some manganite and psilomelane, occur as fissure fillings, irregular masses, and narrow seams surrounding the fragments of brecciated wall rock. Calcite and quartzose vein matter are the predominant gangue constituents.

The ore in the district was mined from surface cuts and in underground open stopes developed from adits and shafts. The deepest workings in May 1954 were about 70 feet vertically below the surface.

History and Production

Although manganese had been known for many years to occur in the central part of the Trigo Mountains, the deposits received no attention until 1953, when a market for low-

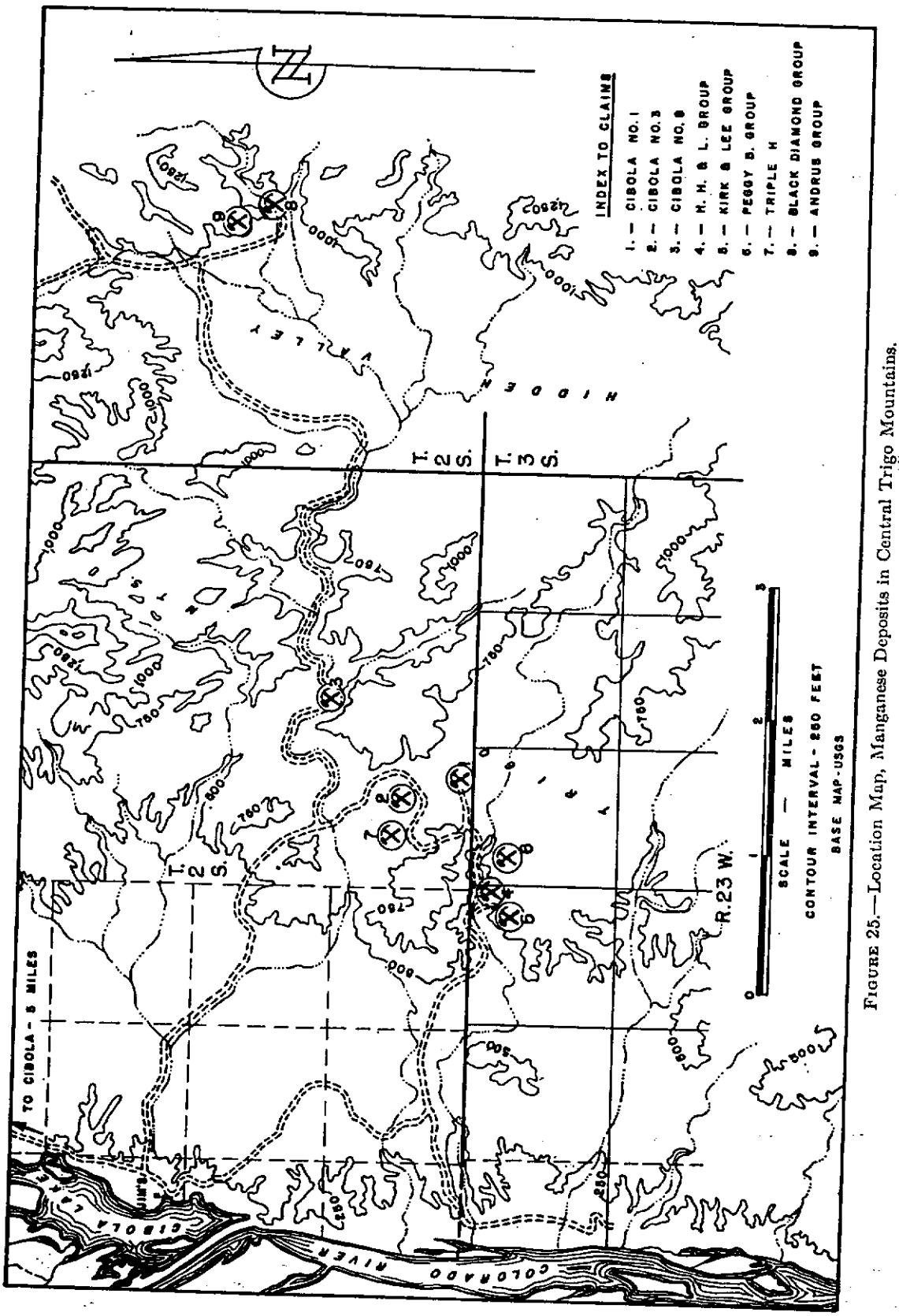

FIGURE 25.—Location Map, Manganese Deposits in Central Trigo Mountains.

grade manganese ore was created by the establishment of the Government purchase depot at Wenden, Ariz. Early in that year the first manganese claims in the central part of the Trigo range were located by the Power brothers, of Yuma, Ariz. Other locations soon followed and, when the area was visited in 1954, 10 properties were active. As estimated by the various operators, production from the district on May 1, 1954, totaled some 3,600 tons of ore containing 22 to 30 percent manganese. All of this ore was trucked directly to the Wenden stockpile, a distance from most claims of about 100 miles.

Cibola Group

The Cibola group of 9 unpatented claims covers parts of approximate secs. 34 to 35, of unsurveyed T. 2 S., R. 23 W. The claims are accessible over 6 miles of winding mountainous road that branches east from the Cibola road about a quarter of a mile north of Jim's Landing on Cibola Lake (fig. 25).

The operators, N. (Doc) Power and J. F. Power, have constructed several miles of access roads and have begun mining operations. When the area was visited late in May 1954, the production from the Cibola claims, according to the Power brothers, totaled about 2,800 tons of ore averaging 25 to 30 percent manganese. This ore had been mined from three claims of the group, the Cibola Nos. 1, 3, and 8.

Cibola No. 1 Claim.—Manganese mineralization in Cibola No. 1, the south claim of the group, occurs in a fracture zone that trends north and follows a fault contact between the older granitic rocks and the younger volcanics. The vein is exposed along the strike for several hundred feet. It ranges from 2 to 10 feet in width and dips 30° to 45° W.

The mineralized part of the fracture was developed by an inclined shaft that followed the vein down the dip for about 132 feet. A single level at an inclined depth of 120 feet extended along the vein for 125 feet north of the shaft and some 30 feet south. Several lenticular ore shoots were exposed by this work. At the time of the visit this development had just been completed, and a stope about 50 feet long was being started in the north drift. According to Power, about 700 tons of ore containing 22 to 30 percent manganese had been produced from the deposit. Future production at the rate of approximately 200 tons of ore a month was anticipated.

The equipment included a portable air compressor and a small hoist, both driven by gasoline engines. Small air-leg-type rock drills were used in drilling. The broken ore was shoveled by hand into wheelbarrows and trammed to the shaft, where it was hoisted in a bucket running on timber skids. Upon reaching the surface, the ore was carefully hand-sorted before it was placed in the ore bin.

Cibola No. 3 Claim.—The deposits on the Cibola No. 3 claim occur along a fractured or brecciated zone about half a mile north and slightly west of the occurrence on the Cibola No. 1 claim. The zone of brecciation, ranging from 10 to 20 feet in width, strikes north, dips steeply westward, and can be traced on the surface more or less continuously for over 500 feet. The better mineralized parts of the fracture appeared to range from 3 to 6 feet in width. An area of lower grade mineralization up to 20 feet in width was exposed on the surface for a short distance near the center of the brecciated zone.

The more promising mineralized outcrops along the fracture had been explored by a short, shallow adit and 2 shafts about 30 feet deep. The shafts were about 400 feet apart, and the adit was some 90 feet north of the north shaft. At the time of the visit the adit was being driven to reach the ore in the north shaft. Exploration of the zone had not progressed sufficiently to indicate the extent of the ore bodies. About 50 tons of sorted ore containing 30 percent manganese had been shipped from the claim to the Wenden stockpile.

Cibola No. 8 Claim.—This claim, about a mile northeast of Cibola No. 3, is traversed by a steeply dipping fracture trending north and cutting volcanic rocks. The manganese minerals occur within the fracture in a series of disconnected lenticular shoots that range from 1 to 10 feet in width.

The deposit, known as the Power No. 1 mine, was developed by a steeply inclined shaft 70 feet deep. From the shaft two levels were driven along the fracture. The upper level, 35 feet below the collar of the shaft, was 325 feet long, and the lower level, 70 feet below the shaft collar, was about 220 feet long. Several lenses of ore occurring at irregular intervals along the fracture had been stoped to various heights above the levels. The largest of these stopes (on the upper level) was about 125 feet long, 20 to 30 feet high, and about 10 feet at its widest point. From this maximum width the ore decreased gradually in thickness until it was less than 2 feet in width at each end of the stope. The other stopes were less extensive and were separated from each other by narrow, poorly mineralized vein matter of various lengths. The ore lenses on the lower level appeared to be shorter and not as well mineralized as those on the upper level.

Pyrolusite was the chief manganese mineral. The gangue consisted largely of unreplaced wall rock, calcite, and probably other carbonate minerals.

The ore was mined in open stopes. Only occasional stulls were needed to support the walls. The blast holes were drilled with light air-leg-type rock drills. The broken ore was shoveled by hand into wheelbarrows and trammed to the shaft, where it was hoisted to the surface in a small skip. The ore was carefully hand-sorted before it reached the ore bin.

Production from this deposit on May 1, 1954, according to Power, had aggregated nearly 2,000 tons of ore averaging about 25 percent manganese. In May 1954, 150 to 200 tons of ore was being produced monthly.

The major equipment consisted of a portable gasoline-driven compressor, a 10-hp. gasoline hoist, and 2 dump trucks.

Hess, Hess, and Lilly Claims

This group, known locally as the H. H. and L. property, is about 4 miles southeast of Jim's Landing in sec. 4, T. 3 S., R. 23 W. The claims lie along a road that branches south from the Cibola road (fig. 25).

The claims were located in 1953 by Hess and Lilly and later were acquired and explored by Kirk and Lea, realtors of Bell, Calif. So far as known, the production has amounted to only a few truckloads of sorted ore, which according to Joe Lowe contained about 30 percent manganese. When visited in May 1954, the property was idle, and all the equipment had been removed.

Mineralization occurs within a brecciated zone that strikes northeast and dips steeply west in volcanic rocks. The deposit had been explored by a shallow open pit about 75 feet long and 10 to 20 feet wide. The manganese minerals exposed in the pit occurred in irregular, discontinuous masses and veinlets surrounded by masses of unreplaced lava. Several hundred tons of mineralized material had been removed from the excavation and placed in stockpiles along the road.

The manganese minerals, consisting of psilomelane and pyrolusite, occur in a gangue of silicified volcanic rock.

Another group of claims known as New Year Nos. 2 and 3, held by Kirk and Lea, is a short distance southwest of the H. H. and L. claims. The manganese occurrence on this property was similar to that found on those claims. About 10 tons of sorted ore had been shipped. At the time of the visit 3 men were employed in breaking and sorting ore from an opencut about 40 feet long.

Peggy B Claim

The Peggy B group of two unpatented claims is about a mile east of the H. H. and L. deposit. The claims were located early in 1954 by John M. Brown, of Blythe, Calif. When visited in May of that year, mining operations were just getting under way, and only a few tens of tons of ore had been produced.

Manganese mineralization occurs along a vein or fracture zone trending north in volcanic rocks. The vein dips about 30° W. and was exposed for about 100 feet along the surface. The higher grade ore within the fracture ranged from 2 to 3 feet in width. Two lenticular ore shoots about 25 feet long were being explored from inclined shafts that had reached a depth of about 20 feet below the surface. The principal manganese mineral was pyrolusite occurring in a gangue of calcite and wall-rock inclusions.

Triple H

The Triple H claims are approximately in unsurveyed sec. 34, T. 2 S., R. 23 W., about half a mile west of the Cibola No. 3 claim.

The group was located in 1954 by Robert Bishop, of Blythe, Calif. When visited in May 1954, the property had recently been leased to Floyd Brown, of Wenden, Ariz., and exploration of the deposit was just getting under way.

Manganese mineralization was exposed in a shallow opencut for about 75 feet along the strike. The higher grade ore, ranging from 2 to 3 feet in width, occurs along the footwall of a steeply dipping fracture trending north and cutting volcanic rocks. In places, lower grade mineralization up to 10 feet in width was exposed along the hanging wall of the fracture zone. About 30 tons of the higher grade ore had been mined from the cut and was awaiting shipment to the Wenden purchase depot. A lot of similar ore that had been shipped to Wenden contained about 23 percent manganese.

Black Diamond Group

The Black Diamond group, comprising 6 unpatented claims, is in the south central part of unsurveyed T. 2 S., R. 22 W., about 14 miles by road east of Cibola Lake. The property is accessible over 9 miles of a road that branches east from the access road to the Cibola claims about 5 miles east of Jim's Landing. When visited in May 1954, a new road extending northeast was under construction; this will make the property more readily accessible from State Route 95 and materially shorten the distance to the Wenden purchase depot.

The claims originally were located in 1953 by Cornelius Lopez and were acquired a short time later by K. C. Gibson, of Roll, Ariz. By the end of April 1954 about 800 tons of ore containing 21 to 34 percent manganese had been shipped to the Wenden purchase depot. Several hundred tons of similar ore had been mined and stockpiled, awaiting the completion of the new road before being trucked to Wenden.

The manganese deposits on the property were found within an extensive zone of brecciated lava. The zone, striking northeast and dipping steeply west, was as much as 450 feet wide and was traceable for over 600 feet. Within the central part of this brecciated area, three or more separate ore bodies had been discovered and developed. The principal ore bodies were roughly parallel and were spaced 150 to 200 feet apart. The eastern ore body had been explored by a shallow opencut about 50 feet long. The central deposit was developed by 2 shafts, 30 and 50 feet deep, and by 150 feet of lateral work. The western ore body was opened by an adit that followed the mineralization for 160 feet along the strike. The face of the adit was about 60 feet below the surface. The minable ore exposed in these openings occurred in a series of lenticular shoots ranging from 2 to 8 feet in width and from 20 to over 100 feet in length. The ore shoots were separated by intervals of poorly mineralized material.

The chief manganese minerals were pyrolusite and psilomelane. The gangue was composed largely of calcite and brecciated fragments of the wall rocks.

The ore was mined underground in open stopes. The walls of the ore bodies were strong and needed very little support. Wheelbarrows were used in place of cars and track for tramming the broken ore. Compressed air for the air-leg-type rock drills was supplied by portable gasoline-driven compressors. Small gasoline hoists were in use at the shafts.

Production from the property in May 1954 was at the rate of about 250 tons of ore a month. This was expected to be increased materially upon completion of the new road. The mine camp was a short distance west of the workings.

Andrus Claims

The Andrus group of two unpatented claims is on top of a prominent ridge about half a mile north of the Black Diamond group.

The claims were located in 1954 by V. A. Andrus, of Blythe, Calif. When the area was visited in May 1954, two men employed by Andrus were exploring the deposit. About 50 tons of sorted ore had been mined, but none had been shipped. An aerial tramway was under construction to facilitate the removal of the ore from the top of the ridge.

Manganese mineralization, largely psilomelane, occurred in bunches and veinlets along a fracture zone in volcanic rocks. The work at the time of the visit was limited to a few scattered surface cuts and pits, which did not indicate the extent of the deposit.

Montoya Claims (Black Jack)

Two unpatented claims owned by Ernesto Montoya, of Blythe, Calif., are about 3 miles northwest of the Black Diamond group. The deposit was discovered and located shortly before the area was visited in May 1954.

Manganese mineralization, consisting of the common oxides, occurs in a lenticular ore shoot within a fracture zone trending north and cutting volcanic rocks. The deposit was exposed in an opencut for about 50 feet along the strike. The higher grade ore ranges from 1 to 3 feet in width and appears to dip 35° W. Three men were employed, and a few tens of tons of sorted ore had been produced. Other disconnected manganiferous outcrops were evident along the trend of the fracture zone.

ABC Claims (Self Mine)

The ABC claims, known as the Self mine, comprise a group of 6 unpatented claims on the eastern slope of the Trigo Mountains about 5.5 air miles northeast of the Black Diamond deposit. The property is in SW¼ sec. 1, T. 2 S., R. 22 W., and can be reached over 12 miles of a road that branches south from the Cibola road about 12 miles west of State Route 95.

The claims were located in 1948 by Carl and Harvey L. Self, of Yuma, Ariz. During the following 2 years the Self brothers operated the property and produced several hundred tons of sorted ore averaging slightly over 40 percent manganese. This ore, the first produced from west central Yuma County, was trucked to Blythe, Calif., and shipped by rail to different steel manufacturers. Early in 1954 the property was leased to E. H. Cockrum and T. H. McNelly. When visited in May 1954, the lessees had shipped about 34 tons of ore containing some 41 percent manganese to the Wenden purchase depot.

The manganese deposits on the property occur in two parallel veins cutting volcanic rocks. The veins are about 150 feet apart, strike north, and dip steeply west. The ore in both veins had been mined in opencuts that reached a maximum depth of about 20 feet below the surface. The higher grade ore exposed in the cuts ranged from 1 to 3 feet in width and had evidently been mined more or less continuously along the strike of both veins for about 125 feet. At the time of the visit the lessees were starting a shaft on the north end of the west vein, from which they intended to develop the deposit at greater depth.

Psilomelane was the predominating manganese mineral. The gangue consisted largely of brecciated fragments of wall rock.

Fools Folly

The Fools Folly group of five claims covers parts of secs. 1 and 2, T. 1 N., R. 21 W., near the north end of the Trigo Mountains. The property is owned by E. W. Jarrell, of Yuma, Ariz. It is accessible over 10 miles of poor road that branches northeast from the Cibola road about 22 miles west of State Route 95. It also may be reached over 13 miles of very poor road that branches northwest from State Route 95 about 16 miles south of Quartzsite, Ariz.

The claims are said to have been located as early as 1930, and a small amount of ore was produced at that time. They were relocated early in 1954 and operated by a partnership, Snipes, Smith, Jarrell, and Richardson. Between May 1954 and May 1955 about 236 long tons of sorted ore averaging 20 percent manganese was shipped from the deposit to the Government purchase depot in Wenden, Ariz.

Two men were employed when the property was visited on July 14, 1955. At that time ore was being mined for treatment in a custom mill recently completed near Jim's Landing on Cibola Lake.

Manganese minerals occur on the claims along a steeply dipping fracture zone trending east in volcanic rocks. The fracture extends more or less continuously for about 700 feet along the strike. In this distance 2 ore shoots about 500 feet apart had been found and developed. The western deposit had been explored by a 125-foot crosscut adit that intersected the fracture about 50 feet below the surface. These were old partly caved workings and were not visited. According to E. W. Jarrell, a small quantity of ore had been mined in this area in the early 1930's, and some ore still remained in the workings. The ore constituting the late production was mined in the eastern deposit from an opencut and an inclined shaft said to be 67 feet deep. The ore body exposed in the opencut was about 35 feet long and 2 to 6 feet wide. The shaft, which is in the east end of the cut, had been abandoned and largely filled with waste. Some ore was still exposed in the bottom of the opencut and also in its west face.

Pyrolusite was the principal manganese mineral. The gangue consisted largely of unreplaced fragments of the volcanic country rock.

Metate

The Metate group of three unpatented claims is on the west slope of the Dome Rock Mountains in sec. 22, T. 3 N., R. 21 W. The property is accessible over 3 miles of unimproved dirt road that branches south from United States Highway No. 60–70 about 12 miles west of Quartzsite, Ariz.

The claims were located late in 1953 by the present owner, Jesus Daniels, of Blythe, Calif. Operations were begun in 1954, and at the end of April 1955 a total of 194 long tons of ore averaging 41 percent manganese had been shipped to the Government purchase depot in Wenden, Ariz. Five men were employed when the property was visited in April 1955.

High-grade bodies of manganese oxides occur on the property as irregular replacements along a minor fold in limestone. The limestone strikes north and dips moderately west. Coarse-grained granitic rocks are exposed a short distance east of the deposit. Alluvium covers the area immediately west of the mineralized outcrop.

Ore had been mined from disconnected bodies for about 50 feet along the strike of the limestone and to a depth of 25 feet below the surface. The individual ore bodies ranged from a few inches to several feet in thickness and from 3 to 12 feet in length. The largest body exposed at the time of the visit had been mined more or less continuously for about 20 feet down the dip. It appeared to be localized in a westerly dipping fissure zone cutting the northern flank of the fold in the limestone.

The ore was composed largely of soft pyrolusite relatively free of gangue. Very little sorting was necessary to attain a grade of 40 percent manganese.

The workings consisted of several opencuts and a 25-foot vertical shaft. At the time of the visit a drift had been started on an ore body exposed near the bottom of the shaft.

La Angora

La Angora group of 2 unpatented claims is in sec. 15, T. 3 N., R. 21 W., about 1.5 air miles northeast of the Metate deposit. The same road from United States Highway No. 60–70 serves both La Angora and the Metate properties.

The claims were located in January 1955 by W. R. Sandoval and associates, of Blythe, Calif. Production at the end of April 1955 totaled about 136 long tons of ore averaging 43.7 percent manganese. Six men were employed when the property was visited early in April 1955.

The ore occurs in irregular bodies in limestone under much the same geologic conditions as on the Metate property. The principal ore body, which furnished the bulk of La Angora production, appeared to follow a bedding-plane fracture striking north and dipping about 40° W. The ore, ranging from a few inches to 2 feet in thickness, was exposed in places for about 30

feet along the strike and to a depth of some 20 feet below the outcrop.

Pyrolusite was the chief manganese mineral. The gangue consisted of small quantities of unreplaced limestone and calcite.

The workings consisted of an open pit, which followed the ore down the dip for some 20 feet.

National Debt

The National Debt group, comprising four unpatented claims, is in sec. 35, T. 4 N., R. 16 W. The property is accessible over 4 miles of dirt road that branches south from United States Highway No. 60–70 about 22 miles west of Wenden, Ariz.

The claims were located early in 1953 by the present owner, L. C. Huthmacher, of Wenden, Ariz. Mining was begun shortly thereafter, and during 1953 and 1954 a total of 796 long tons of sorted ore averaging 20.2 percent manganese was shipped to the Government purchase depot in Wenden, Ariz. Of this total, lessees produced some 19 tons, and L. C. Huthmacher mined the balance. The property was idle when visited in September 1954, but it was reported that Huthmacher resumed operations early in 1955 and shipped an additional 16.5 tons of ore during January 1955.

The ore occurs in two steeply dipping fracture zones cutting volcanic rocks. The zones strike west and dip north. The productive parts of the zones are well over half a mile apart. The ore in the west zone occurred in a lenticular crescent-shaped body about 100 feet long. The central part on the surface was about 14 feet wide. From the center of the lens the ore gradually pinched along the strike to a width of a foot or less at each end. It likewise pinched down the dip, and at a depth of about 30 feet below the outcrop the ore was less than a foot wide.

The ore produced from the other occurrence at the eastern end of the property was mined from a fracture zone exposed for some 300 feet. The higher grade ore in this zone occurs in irregular disconnected masses ranging from 1 to 3 feet in width. Lower grade material up to 10 feet in width occurs in the wall rocks adjacent to the better ore.

The principal manganese minerals on the property are pyrolusite and psilomelane. The gangue consists chiefly of unreplaced fragments of wall rock and calcite.

The workings in the eastern zone consisted of a series of opencuts and pits spaced at irregular intervals along the outcrop. The deepest openings were about 25 feet below the surface. According to L. C. Huthmacher, about 300 tons of ore was produced in this area.

The crescent-shaped western ore lens was mined in an open stope from a short adit level. About 500 tons of sorted ore was produced from this occurrence.

Hidden Treasure (Magic Group)

The Hidden Treasure property of three claims is near the base of the southern slope of the Harquahala Mountains in sec. 29, T. 5 N., R. 11 W. The claims are at the end of a 6-mile road that branches northeast from the Salome-Hassayampa Road about 12 miles south of Salome, Ariz. The access road ends at a cabin from which the workings can be reached over a short northerly trending trail.

The property has been operated intermittently as a gold mine since its discovery in 1932. According to the present owner, Edwin J. Johnson, of Salome, Ariz., the mine has produced about 50 cars of shipping ore valued at approximately $50,000 in gold. No manganese ore was produced until 1953. During 1953 and 1954 several small lots of sorted ore containing about 20 percent manganese were mined and shipped by lessees to the Government purchase depot in Wenden, Ariz. The property was idle when the area was visited in March 1955.

Manganese oxides occur on the property in seams and irregular replacement bodies along a fracture zone in limestone. The zone strikes north, dips very steeply east, and ranges from 2 to 8 feet in width. In a distance of several hundred feet two separate areas containing appreciable quantities of manganese have been found along the outcrop. These mineralized areas contain numerous seams and occasional podlike bodies of manganese oxide surrounded by unreplaced limestone. Most of the ore shipped to the Wenden purchase depot was mined from the larger of these occurrences in an open pit about 25 feet long, up to 8 feet wide, and not over 10 feet deep. The ore was less than a foot wide at each end of the opening. The bottom of the pit was covered with broken rock, so the downward extent of the ore body was not disclosed. In the other occurrence to the southwest the ore was about 2 feet wide and was exposed in a shallow opencut for a few feet along the strike.

The principal manganese mineral is pyrolusite. The gangue is composed of calcite, limonite, and silicified limestone.

Dreiser

The Dreiser property comprises three patented claims and a millsite, known as the Iron Trail, Star Nos. 2 and 3, and Dreiser Spring millsite. They are near the summit of the south slope of the Harquahala Mountains in sec. 16, T. 5 N., R. 11 W., about 3 air miles northeast of the Hidden Treasure mine. The

claims are accessible by 2 miles of foot trail that follows the west side of a northerly trending canyon about half a mile east of an old cabin at the Silver Queen mine. This cabin can be reached from Salome by traveling 12 miles south over the Hassayampa Road, thence 3.6 miles east-northeast toward the Hidden Treasure mine to a faint road forking eastward, and over the east fork for 3.2 miles to the cabin, where the road ends and the trail begins.

The history of the property is not well known. The claims are said to have been located in 1916 as a gold prospect. They were patented in 1920 and are owned by Arthur H. Dreiser, of Pasadena, Calif. There are no records indicating that any gold or manganese ore was ever shipped. The property has been dormant for many years.

Manganese oxides, associated with an abundance of iron oxides, occur on the claims in large replacement bodies along a broad zone of metamorphosed limestone. The limestone strikes east, dips 15° to 30° N., and is exposed for several thousand feet in an arc partly encircling the north end of a boxlike canyon. Along this arc 10 or more disconnected bodies of iron and manganese oxides crop out in a zone 150 feet wide and some 2,000 feet long. The larger mineralized bodies range from 100 to 500 feet in length and from 10 to 30 feet in width. They occur in the zone in an overlapping pattern and appear to be more or less conformable in strike and dip to the bedding planes of the limestone. In places mineralized cross fractures up to several feet in width extend outward from the walls of the larger bodies. Faulting is quite prevalent in parts of the area where it appears to have offset the mineralized zone.

Pyrolusite and psilomelane are the principal manganese minerals. The gangue is composed largely of limonite, goethite, and calcite. Goethite, an oxide of iron, occurs in glossy dark-brown radiating crystals.

The principal workings consisted of a 60-foot adit and a single-compartment shaft estimated to be about 80 feet deep. These openings were about 300 feet apart. About midway in the adit a shallow, slightly inclined winze had been sunk along the hanging wall of one of the larger mineralized bodies. Both the shaft and the winze were inaccessible.

The manganese content of the deposits varies greatly from place to place. A few characteristic samples collected in different parts of the property ranged from 7 to 20 percent manganese and from 20 to 35 percent iron.

Black Hawk (Livingston)

The Black Hawk group of eight claims, owned by J. R. Livingston, of Quartzsite, Ariz., is in secs. 33 and 34, T. 1 N., R. 12 W. The property is about 35 miles by road south of Salome, Ariz., and some 30 miles north of Horn, Ariz., a siding on the Phoenix Branch of the Southern Pacific Railroad about 50 miles west of Gila Bend, Ariz. The claims are north of Horn on a desert road passing through Clanton Well and Deadman Tank. Other unimproved roads lead to the property by way of Salome or from the Sheep Tanks mine road from the north and west.

The claims were located in 1941 by A. B. Miner and J. R. Livingston. A small quantity of sorted ore was produced in 1942. So far as known, there was no further activity until 1953, when the property was leased to L. A. Aplington, of Quartzsite, Ariz. During May 1953 approximately 38 tons of sorted ore containing 22 percent manganese was shipped by Aplington to the Government purchase depot in Wenden, Ariz. The property was idle when it was visited on May 4, 1955.

The deposit consists of stringers and irregular veins of manganese oxides occupying a northwesterly trending zone in volcanic rocks. The zone contains numerous widely separated manganiferous outcrops in an area well over a mile long and as much as several hundred feet wide. The mineralized fractures strike and dip in various directions and range from an inch to 2 feet in width and from a few feet to as much as 150 feet in length. The ore in the wider and more persistent veins occurs in disconnected lenticular bodies spaced irregularly along the outcrop. In some places the thin seams and veinlets are quite closely spaced, forming irregular areas of low-grade mineralization.

Pyrolusite and psilomelane are the principal manganese minerals. The gangue consists chiefly of calcite and jasper.

The workings comprise 15 or more scattered pits and shallow opencuts on the more promising outcrops. The largest of these openings was about 150 feet long, 5 feet wide, and up to 10 feet deep. The ore was hand-sorted from a much larger quantity of the lower grade vein matter broken in the various pits and opencuts.

Black Dahlia

The Black Dahlia group of four claims is in sec. 7, T. 2 S., R. 16 W., along the southwestern flank of the Kofa Mountains about a mile northeast of the old King of Arizona gold mine. The property is accessible from the Roll-Wellton semi-improved country road, which branches east from State Route 95 at Stone Cabin, a gasoline filling station about 28 miles south of Quartzsite and 56 miles north of Yuma, Ariz. From Stone Cabin, the claims can be reached by traveling east over the Roll-Wellton road for 15 miles to a northeast branch, north on this

branch for 8 miles, and thence 2 miles on a southeast fork to the deposit.

The claims are said to have been located originally during World War II and then abandoned. Glenn Morten, of Quartzsite, Ariz., relocated them in 1950. In 1953 the property was purchased and worked by Alton B. Carter, of Blythe, Calif. During 1953 and 1954 a total of some 230 long tons of sorted ore averaging about 27 percent manganese was shipped by Carter to the Government purchase depot in Wenden, Ariz. Operations were terminated late in 1954.

Manganese mineralization occurs on the property along two fracture zones in volcanic rocks. The fractures are about 100 feet apart; both strike northwest and dip very steeply northeast.

The eastern zone was exposed for about 150 feet along the strike and was mineralized in places to widths of as much as 8 feet.

The western fracture was traceable for approximately 300 feet along the strike and ranged from 10 to 20 feet in width.

The ore in both zones occurred in irregular, disconnected bodies composed of veinlets and bunches of manganese oxides distributed erratically within masses and fragments of the fractured country rock. The veinlets ranged from a fraction of an inch to several inches in width. Some of the manganiferous bodies were several feet in their greater dimension.

Ore had been mined from both zones in a series of opencuts spaced at irregular intervals along the better mineralized portions of the fractures. The largest and deepest of these cuts was about 100 feet long, up to 10 feet wide, and 10 to about 30 feet deep. The ore shipped to Wenden was hand-sorted from the material broken in the various openings. The greater part of the material mined was rejected as waste.

The manganese minerals are essentially pyrolusite and small amounts of psilomelane. Calcite is the most abundant gangue mineral.

The best ore was found near the surface. The vein material exposed in the bottom of the deepest openings consisted largely of low-grade manganiferous calcite.

Black Top

The Black Top group of five claims follows the foothills bordering the east side of the Castle Dome Mountains in the west central part of unsurveyed T. 4 N., R. 17 W. The property can be reached over a short access road that branches west from the Roll-Wellton County road about 25 miles southeast of Stone Cabin on State Route 95. Roll or Growler sidings on the Phoenix Branch of the Southern Pacific Railroad are some 25 miles to the south and are the nearest rail shipping points.

The claims appear to have been located and abandoned several times since the First World War. In 1939 they were held by Samuel Neahr, of Yuma, Ariz.; in 1952 they were relocated by William Ruggles; and 2 years later they were acquired and operated by the Sturges-Worthington Mining Co., Yuma, Ariz. During 1954 and the early part of 1955 this company shipped about 384 long tons of ore averaging 26 percent manganese to the Government purchase depot in Wenden, Ariz. The operation was discontinued in March 1955.

Several manganese-bearing veins cutting volcanic flow rocks are exposed on the property. They strike northwest and dip steeply northeast. The vein that has yielded most of the ore can be traced for several hundred feet along the outcrop. It ranges from 2 to 6 feet in width. A few hundred feet to the south 2 other relatively short veins 2 to 3 feet wide crop out.

In the main vein the ore occurs in disconnected lenticular shoots composed of stringers and podlike bodies of manganese oxides intermingled with calcite, quartz, and rock fragments.

Pyrolusite and psilomelane are the principal manganese minerals.

The ore shipped to the Wenden purchase depot was sorted from the lower grade vein material mined in opencuts that extended for about 200 feet along the outcrop of the main vein. The deepest openings were some 30 feet below the surface.

Lower grade material consisting largely of manganiferous calcite was found in the bottom of the deepest cut.

Black King

The Black King group of 19 claims is 32 miles by road northwest of Horn Siding in unsurveyed T. 3 S., R. 15 W. The property can be reached from Horn by traveling north for 10 miles on the Clanton Well road and thence northwest for 22 miles on an unimproved desert road.

The claims are said to have been located during World War I. They were abandoned a short time later and appear to have been relocated in 1939 by Cecil Martin, of Lordsburg, N. Mex. In 1951 they again were relocated by V. R. Morrison, of Quartzsite, Ariz. In 1952 the claims were acquired by the present owner, F. A. Sitton, of Phoenix, Ariz.

The known production from the property has totaled some 47 tons of sorted ore containing 25 to 30 percent manganese. This ore was shipped by lessees in 1951 to the Government purchase

depot in Deming, N. Mex. No work was in progress when the area was visited early in May 1955.

Manganese mineralization on the property occurs in six widely separated veins cutting volcanic rocks. The veins strike north and dip steeply both west and east. They range from 100 to several hundred feet in length and from 1 to 10 feet in width. The ore in the veins occurs in disconnected lenticular bodies composed of veinlets and irregular pods of manganese oxides surrounding unmineralized fragments of the brecciated wall rocks. The higher grade ore bodies are 10 to 50 feet long and 1 to 3 feet wide. In places lower grade material extends into the walls of the fractures to as much as 10 feet.

Pyrolusite and psilomelane are the principal manganese minerals. The gangue consists of manganiferous calcite and wall-rock inclusions.

The veins had been explored by a number of shallow openings consisting largely of pits and opencuts. The bulk of the ore shipped from the claims was mined from adit workings near the west side of the property. These workings were inaccessible, but from the surface the ore above the adit level appeared to have been stoped from a series of short lenses that extended for about 150 feet along the strike of the vein.

Sheep Tanks

The Sheep Tanks property of 14 claims is in sec. 1, T. 1 S., R. 15 W., near the southern margin of the Little Horn Mountains. It is accessible over 27 miles of desert road that branches south from United States Highway No. 60–70 about 10.5 miles west of Salome, Ariz.

The property has been operated intermittently as a gold-silver mine since its discovery in 1909. It was purchased in 1927 by the Sheep Tanks Mines Co. During 1928 and 1929 operations were conducted by Ibex Mines Co. The production in 1929 [16] totaled 801 tons of smelting-grade ore containing 1,303 ounces of gold and 12,525 ounces of silver valued at $33,514. The ore was trucked to Vicksburg and Hyder and shipped by rail to the Hayden, Ariz., smelter. In 1931 the Anozira Mining Co., which later became the Sheep Tanks Consolidated Mining Co., purchased the property and did considerable prospecting and development work. A 100-ton cyanide mill was built and operated during 1934 and 1935. After some 15,000 tons of ore had been treated, the operation was terminated, and the mill and other equipment were liquidated. A short time later the property was purchased by Edwin W. Mills, of Salome, Ariz. During 1939 and 1940 lessees shipped 1,283 tons of gold-silver ore to the Hayden smelter.

As far as known, no manganese ore, as such, has been shipped from the property. Not until 1953, after the opening of the Government manganese purchase depot in Wenden, Ariz., was any attempt made to mine the ore strictly for its manganese content. At that time lessees selectively mined several tens of tons of the higher grade manganese-bearing material, but apparently it was not shipped. When the mine was visited on May 5, 1955, this material still remained in two small piles near the former millsite.

Manganese oxides occur on the property in several veins and brecciated zones cutting volcanic rocks. The principal vein, known as the Resolution, strikes west and dips north at a low angle. It is exposed for approximately 700 feet along the strike and ranges from a few feet to as much as 40 feet in width. The vein is composed of irregular masses and streaks of limonite, pyrolusite, quartz, and calcite. Most of the gold-silver ore formerly produced was mined from this deposit in a number of stopes extending above a long tunnel level.

Another vein some 300 feet to the north was exposed in the tunnel workings. It strikes northwest and dips about 50° NE. As exposed by several hundred feet of drifts, it averages about 4 feet in width and contains irregular bunches and streaks of pyrolusite intermingled with masses of limonite, quartz, and calcite. The brecciated country rock between this vein and the Resolution vein contains numerous narrow seams filled with limonite and pyrolusite.

Other manganiferous occurrences were found on the Red Top No. 5, Resolution No. 3, and Resolution No. 5 claims. These are all north and east of the north portal of the main tunnel.

On the Red Top No. 5 claim, about 1,200 feet north of the tunnel, a vein trending northwest crops out in places for several hundred feet along the strike. It ranges from 1 to 4 feet in width and is composed largely of a brecciated porphyry cemented by seams and irregular strands of manganese oxides. The exploratory work consisted of a few shallow opencuts.

Farther southeast and extending into the Resolution No. 5 claim is a broad, mineralized zone consisting of widely spaced stringers and occasional bunches of pyrolusite and limonite. The zone is exposed on the surface for about 200 feet along the strike and appeared to be as much as 50 feet wide. About 20 tons of manganiferous material, piled nearby, evidently had been mined in an opencut from one of the better mineralized areas in this zone.

[16] Bureau of Mines, Mineral Resources of the United States, 1929, pt. I, p. 827.

On the Resolution No. 3 claim, some 600 feet east of the main tunnel, a manganese-bearing vein occurs along a fault striking northeast and dipping steeply southwest. It is exposed in places for about 150 feet along the strike and ranges from 2 to 6 feet in width. Manganese oxides in a gangue of limonite and calcite occur in the vein as disconnected masses that in places were several feet long and as much as 2 feet wide. The work here was limited to a few shallow pits and opencuts.

In October 1944 approximately 10 tons of Sheep Tanks ore was mined by personnel of the Federal Bureau of Mines for metallurgical testing in an endeavor to recover both the manganese and the gold-silver from the ore.[17] This ore was mined in one of the main stopes above the tunnel level in the Resolution vein. When analyzed, the 10-ton sample was found to contain 3.5 percent manganese, 0.25 ounce of gold, and 8.0 ounces of silver per ton. The results obtained by the metallurgical test work indicated that over 90 percent of the manganese could be recovered by the dithionate process of sulfur dioxide leaching, and an excellent extraction of the gold was obtained by cyanidation either before or after removal of the manganese. However, only about 43 percent of the silver was recovered by cyanidation after virtually all the manganese had been leached out.

Hovatter Claims

The Hovatter property comprises 3 contiguous groups, known as the Barbie, Bombay, and Hill Top, some 30 individual claims in all. The property is in the central part of unsurveyed T. 1 S., R. 15 W., and may be reached from the Sheep Tanks mine by traveling south on the Horn-Palomas road for 4 miles and then northwest about 3 miles on a branch road.

The claims were located in 1953 by the present owner, D. R. Hovatter, of Salome, Ariz. Ore was produced late in 1953 and continued to be mined until April 1955. During this time 230 long tons of sorted ore averaging 18 percent manganese was shipped from the property to the Government purchase depot in Wenden, Ariz.

Manganese oxide minerals occur on the claims in veins and shear zones cutting volcanic flow rocks.

The vein found on the Barbie group, along the west side of the property, strikes N. 20° W. and dips steeply northeast. It was exposed for about 150 feet along the strike and ranged from 1.5 to 6 feet in width. Ore had been mined from the wider part of the vein in an opencut that extended along the outcrop for about 100 feet. The cut reached a maximum depth of some 25 feet below the surface. The ore shipped from this group was hand-sorted from the lower grade vein material broken during the mining operations. The work here had been terminated shortly before the area was visited in February 1955 and the equipment moved to the Hill Top claims.

The Bombay deposit, about half a mile south of the Barbie vein, occurs in a shear zone trending northwest and dipping very steeply northeast. The mineralized portion of the zone is exposed for about 100 feet along the strike and ranges from 4 to 8 feet in width. The ore occurs in parallel stringers and veinlets, ranging from an inch to 6 inches in width, separated by sheared lava. At the time of the visit ore was being hand-sorted from the material broken in an opencut about 80 feet long, 6 feet wide, and up to 10 feet deep.

The Hill Top deposit, as the name suggests, is on the top of a prominent ridge about a mile northeast of the Barbie vein. The ore occurs in overlapping lenses along a zone of sheared lava. The zone strikes N. 70° W. and appears to dip slightly northeast. It was exposed in shallow opencuts for some 200 feet along the strike and ranged from 4 to 8 feet in width. The manganiferous lenses in the zone ranged from a few inches to 2 feet in width. Some appeared to be persistent for 10 feet or more along the strike.

The chief manganese minerals in all the exposures on the property are pyrolusite and psilomelane. The gangue is composed of abundant calcite and fragments of unreplaced country rock.

[17] Romslo, T. M., and Ravitz, S. F., Arizona Manganese-Silver Ores: Bureau of Mines Rept. of Investigations 4097, 1947, 13 pp.