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MANGANESE DEPOSITS OF MEXICO

BY

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MANGANESE DEPOSITS OF MEXICO

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ABSTRACT

Manganese has been reported from 335 deposits in 20 of the 30 States and Territories of México. The production of manganese ore prior to 1942, according to published figures, amounted to about 54,000 tons. For the year 1942 production rose to 35,000 tons, for 1943 to 70,503 tons, and for 1944 to 80,671 tons; but for 1945 it dropped to a little less than 52,000 tons, and during 1946 it continued to drop. Up to the end of 1941 Chihuahua had produced about half the manganese ore from Mexico; San Luis Potosí produced about 17 percent, and Baja California and Zacatecas each about 10 percent. In 1942 Baja California became the chief producer; Durango, Chihuahua, and Zacatecas each yielded somewhat less. During that year the ore came from 76 deposits, of which only 30 yielded more than 500 tons each.

Reserves approximate 1,500,000 tons of inferred ore, of which about half contains more than 42 percent of manganese and the rest approximately 30 percent. This ore is distributed as follows: Baja California, 700,000 tons; Chihuahua, 285,000 tons; Zacatecas, 230,000 tons; Durango, 70,000 tons; San Luis Potosí, 65,000 tons; Sonora, 28,000 tons; Coahuila, 27,000 tons; and lesser amounts in 13 other States.

The deposits are of four main types: (1) fissure deposits, which consist of manganese oxides and calcite in fissures in volcanic rocks (found principally in Chihuahua and Sonora) and (1a) also of thin stringers of manganese oxides widely distributed through a fractured basalt flow (found in the Gavilán deposit on Punta Concepción, Baja California); (2) silicified replacement deposits, consisting of concentrations of manganese oxides and silicates in siliceous replacement zones in fractured tuffaceous and volcanic rocks (found mainly in Zacatedas,. San Luis Potosí, and the southern part of the State of Mexico); (3) limestone replacement deposits, composed of manganese silicates and oxides in limestone adjacent or close to granitic stocks (found in eastern Durango, eastern Coahuila, and northern Guerrero); and (4) tuff replacement deposits, formed of manganese oxides in bedded tuffs (found principally in one deposit, the Lucifer, near Santa Rosalía, Baja California).

The ore of type 1 averages from 25 to 35 percent of manganese and has to be sorted, mostly by hand, to bring the grade up to 40 percent of manganese. That of type 1a contains from 2 to 10 percent of manganese and must be concentrated mechanically. Type 2 ore is high in silica and must be sorted carefully to keep the silica content below 15 percent. Type 3 ore is low in silica, but it contains either somewhat less than 40 percent of manganese or too much lead and zinc to be marked, so it must be specially treated. Type 4 ore is marketed as mined, as it contains 45 percent of manganese and only 5 or 6 percent of silica. The ore of types 3 and 4 tends to contain more than 20 percent of material finer than 20 mesh, which increases the difficulty in marketing it.

Most of the manganese ore is found in a few large ore deposits, notably the Lucifer (type 4) and Gavilán (type 1a) deposits in Baja California and the Talamantes (type 1) deposit in southern Chihuahua, each with reserves of more than 125,000 tons. Each of several deposits of type 2 in central Zacatecas has reserves of 10,000 to 50,000 tons of ore containing about 40 percent of manganese and from 10 to 20 percent of silica. The Sarnosa and Luz deposits, near Torreón, Coahuila, and the Milagro deposit (type 3) in eastern Coahuila have 10,000 to 25,000 tons of ore each, containing 38 or 40 percent of manganese and about 5 percent of silica. Most of the other deposits have reserves of only a few thousand tons of ore or less.

INTRODUCTION

This report is the result of an investigation of the manganese deposits of Mexico made by the Geological Survey, of the United States Department of the Interior, in cooperation with the Dirección General de Minas y Petróleo, the Instituto de Geología, and the Comité Directivo para la Investigación de los Recursos Minerales de México, agencies of the Mexican Government. Parker D. Trask undertook the study for the Geological Survey, and José Rodríguez Cabo, Jr., for the Mexican Government. The work was done as part of the program for cooperation with the American Republics sponsored by the Interdepartmental Committee for Scientific and Cultural Cooperation of the United States Department of State, and was greatly facilitated by the support given it by the Hon. George S. Messersmith, Ambassador of the United States to Mexico.

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Special acknowledgment is due to Mr. Floyd D. Ransom, Special Representative of the Foreign Economic Administration of the United States Government, and to his associates Messrs. James F. McGee and William B. Kane, for their cordial cooperation during the investigation. Grateful appreciation is expressed to Ing. Germán García Lozano, Chief of the Dirección General de Minas y Petróleo, for his active interest and support of the work, and to Ing. Teodoro Flores, Acting Director of the Instituto de Geología, for his many courtesies, especially in providing laboratory and office facilities needed for the successful completion of the project. Valuable assistance was also rendered by D. F. Hewett, W. F. Foshag, J. V. N. Dorr 2d, W. D. Johnston, Jr., and Ivan F. Wilson, of the Geological Survey. The authors are particularly grateful to Carl Fries, Jr., of the Geological Survey, for his assistance in editing the manuscript for publication.

FIELD WORK AND SCOPE OF REPORT

The purpose of the investigation was to obtain quickly a general idea of the possibility of increasing the production of manganese ore in Mexico, because of the urgent need for this metal in the United

States in 1943. Field work was carried on by the writers for 5 months, between February and June 1943. Obviously, it was impossible to visit all the ore bodies on record within the time available, but an attempt was made to examine the more actively mined deposits and to obtain as much information as possible about those that could not be examined. Records were assembled of some 335 deposits in 20 States of the Republic. All the information is presented that could be obtained or was available up to July 1, 1943, on these Mexican manganese deposits. In addition, results are given of detailed studies of the larger Lucifer, Gavilán, Talamantes, Montaña de Manganeso, and Abundancia ore deposits. These studies were made in 1944 by I. F. Wilson in cooperation with Mario Veytia and V. S. Rocha, subsequent to the authors' visit to those particular deposits.

Manganese is most widely distributed in the State of Chihuahua, which has 90 deposits; Zacatecas is next with 33 deposits, then in order are Sonora with 29, Durango with 29, and Baja California with 22. (See pl. 39.) Of these deposits, about 150 were visited by the writers and 10 others were examined by I. F. Wilson and D. E. White, of the United States Geological Survey, in cooperation with Mexican geologists. The ore from 40 other deposits was seen either in hand specimens or in stock piles. Information on many other deposits was obtained through personal discussions with competent observers, who are listed on pages 289–290. Other sources of information were files of the Metals Reserve Co. (10) in Mexico, a report made in 1938 by the American Consular staff in Mexico (2), and a map of the manganese deposits of Mexico prepared by the Instituto de Geología and published in 1941 by the Dirección General de Minas y Petróleo (8).

Previously published descriptions of manganese deposits in Mexico are relatively few. The bibliography in this report gives the known references to Mexican manganese deposits. Throughout the text of the present report, the date in parentheses after an author's name refers to the particular item in the bibliography (p. 285). Thus "Wallace (1911c)" refers to the third paper published in 1911 by Wallace, which is listed as "Wallace, H. V., Manganese in Lower California; Min. and Sci. Press, vol. 103, pp. 201–202, 1911."

Further information on the deposits has been obtained from unpublished sources. A numbered list of these is given on page 289. In the text and in table 17 these sources are referred to by name or number.

The location, ownership, production, reserves, and type of each manganese deposit known in Mexico are given in table 17, and the geographical distribution of the deposits is shown in plate 39. In this plate the deposits are arranged numerically by States, the numbers running consecutively from north to south, and throughout the present report a numerical code based on the State name and number is used to identify the deposits. In many areas where several deposits occur within a few kilometers of one another, it has not been practicable to assign to each deposit a separate number on the map, and consequently a single number is used to represent all the deposits in a given area, each being identified by an alphabetical suffix. Thus "Durango 2b" refers to deposit b in area 2 in the State of Durango. Area 2 is the Dinamita district in eastern Durango, and deposit b is the Sarnosa mine in that area (see table 17 and pl. 39). In the section below describing the individual deposits of the different States, the State name is omitted in referring to the deposit number. (See p. 228.)

PAST PRODUCTION OF MANGANESE ORE

Mexico has never produced large quantities of manganese ore. The total tonnage produced up to the end of 1945, according to statistics published by the Mexican Government, was about 215,000 metric tons. (See table 1.) These statistics are not complete for all years, nor, for some years, do they indicate clearly whether they are for all ore produced or for only that exported. The last column in table 1 gives the maximum tonnage reported for each year, compiled from all available sources. The total tonnage of ore produced amounts to some 292,000 tons, whose average grade is estimated to have been 35 or 40 percent of manganese. The published data for the production from the individual mines are presented in table 17, and for the individual States in table 2.

The ore produced prior to 1942, as indicated in table 2, came from seven States. Some 56,650 metric tons were reported for Chihuahua, 17,500 tons from San Luis Potosí, 10,000 tons for Zacatecas, 9,800 tons for Baja California, 5,500 tons for Sonora, 2,000 tons for Coahuila, and 1,500 tons for Durango. The largest producing mines or districts up to that year were the Talamantes district (Chihuahua 31) in southern Chihuahua, with 45,000 tons; the Montaña de Manganeso mine (San Luis Potosí 1) in north-central San Luis Potosí, with 12,500 tons; the Zacate-Chino area (Chihuahua 27 and 27a) in central Chihuahua, with 12,000 tons; the Negra deposit (Zacatecas 9) near Fresnillo in northern Zacatecas, with 10,000 tons; the Gavilán mine (Baja California 7) on Punta Concepción in Baja California, on the west side of the Gulf of California, with an estimated 9,500 tons; the Borregos deposits (Chihuahua 1) in northern Chihuahua, with 3,500 tons; and the Antillas (Sonora 6) and Carr (Sonora 3) deposits in northern Sonora, each with about 2,500 tons. The Talamantes district had produced steadily for more than 20 years before 1942, and nearly all its ore had gone to the steel plant in Monterrey, State of Nuevo León.

TABLE 1.—*Manganese production in Mexico through 1945, in metric tons*

[By Ivan F. Wilson]

Year	Official Mexican Government statistics [1]			Mineral Resources of the U. S.[2]	Foreign Economic Administration [3]	Maximum reported for each year
	Manganese ore [4]	Metal content [5]	Exports, metal content [6]	Manganese ore		
1897				57		57
1898				58		58
1904	20					20
1905	150					150
1916				396		396
1917	73			350		350
1918	2, 878			5, 335		5, 335
1919	2, 794			6, 396		6, 396
1920	1, 137			[7] 2, 972		2, 972
1921	559					559
1922	700			[8] 508		700
1923	2, 246			2, 246		2, 246
1924	1, 800			1, 800		1, 800
1925	3, 333			3, 333		3, 333
1926	3, 299			3, 299		3, 299
1927	[9] 1, 000			861		1, 000
1928	661			661		661
1929	650			650		650
1930	732			732		732
1931	731	338		731		731
1932	306	[10] 306		700±		700
1933	573	[10] 573		573		573
1934		859		664		[11] 2, 045
1935		1, 363		3, 217		3, 217
1936	3, 377	1, 337		3, 337		3, 337
1937	3, 121	1, 480	17	[12] 17		3, 121
1938	1, 902	816	117	[12] 117		1, 902
1939	1, 241	547	27	[12] 27		1, 241
1940		1, 696	307	[12] 307		[11] 4, 038
1941	2, 156	979	979	[12] 979		2, 156
1942		11, 493			35, 000±	35, 000
1943	[13] 56, 285	22, 946			70, 503	70, 503
1944	71, 235	29, 070			80, 671	80, 671
1945	[14] 51, 949	18, 503				51, 949
Total	214, 908	92, 306	1, 447	40, 323	186, 174	291, 938

[1] Data for 1904–05 and 1917–44 are from an unpublished table, Estadística sobre la producción minero metalúrgica en México desde el año 1521 a mayo de 1944, México, Secretaría de la Economía Nacional, Dirección General de Minas y Petróleo, Oficina de Investigación, 11 August 1944. The data in this table are inconsistent, in that they are evidently based on tonnages of manganese ore to 1933, except for 1931, and on metal content from 1934 to 1944.

[2] Mineral Resources of the U. S., and Minerals Yearbook. Data for 1916–22 are for Mexican exports to the United States. Data for 1923–36 are for total production, based on Mexican Government figures. Data for 1937–41, though labeled "production," are the same as Mexican figures for exports only; moreover, they are based on metal content rather than on tonnage of ore and thus are not comparable to figures for previous years.

[3] Unpublished data collected by representatives of the U. S. Foreign Economic Administration in Mexico.

[4] Data for 1917–33 are from published tables in Anuario de Estadística Minera, México, Departamento de Minas. Data for 1936–39 are from Villafaña, Andrés, Estadísticas mineras mexicanas, 1931–41, p. 67, México, Secretaría de la Economía Nacional, Dirección General de Minas y Petróleo, 1943. Data for 1941–45 are from Boletín de Minas y Petróleo, vol. 16, no. 5, pp. 7–18, 1946.

[5] Data for 1931–41 are from Villafaña, Andrés, op. cit., p. 15. Data for 1941–44 are from unpublished table cited in footnote 1; also from published tables by Keighley, J. R., México, in Minerals Review of Latin America, 1939–44; U. S. Bur. Mines, Foreign Minerals Survey, vol. 2, no. 4, pp. 79, 82, October 1944. Data for 1945 are from unpublished figures of Oficina de Estadística Económica, Secretaría de la Economía Nacional, México.

[6] Published in Boletín de Minas y Petróleo (see bibliography, p. 77 for numbers and pages); also in Villafaña, Andrés, op. cit., p. 43, where the figures are said to refer to exports.

[7] Based on published figure of 2,925 gross tons.

[8] Based on published figure of 500 gross tons.

[9] Anuario de Estadística Minera gives 861 tons.

[10] These figures are evidently in error for metal content, since they are the same as those given for ore in the Anuario de Estadística Minera.

[11] Approximate; calculated from figures for metal content, by assuming an average grade of 42 percent of manganese.

[12] These figures are evidently in error for tonnages of ore, since they are the same as the Mexican Government figures for metal content.

[13] Of this amount, 608 tons consisted of manganese-ore concentrates.

[14] Of this amount, 415 tons consisted of manganese-ore concentrates.

TABLE 2.—*Manganese production in Mexico by States, to Apr. 1, 1943*[1]

State	Production, in metric tons				Deposits that have produced manganese ore	
	Before 1942	1942	January-March 1943	Total to April 1, 1943	Number	Number that have produced more than 500 metric tons
Baja California	9,800	9,200	3,500	22,500	6	2
Chihuahua	56,650	6,400	1,665	64,715	23	11
Coahuila	2,000	490	100	2,590	3	1
Durango	1,500	8,225	3,950	13,675	9	3
Guanajuato		200	300	500	2	
Guerrero		300	100	400	7	
Hidalgo		40		40	1	
Jalisco		100		100	1	
México		800	280	1,080	2	1
Michoacán						
Morelos						
Nayarit						
Nuevo León		100		100	1	
Oaxaca						
Puebla		600	400	1,000	1	1
Querétaro						
San Luis Potosí	17,500	2,000	500	20,000	2	2
Sinaloa		50	100	150	1	
Sonora	5,500	1,200	500	7,200	8	3
Zacatecas	10,000	6,300	5,320	21,620	9	6
Total	102,950	36,005	16,715	155,670	76	30

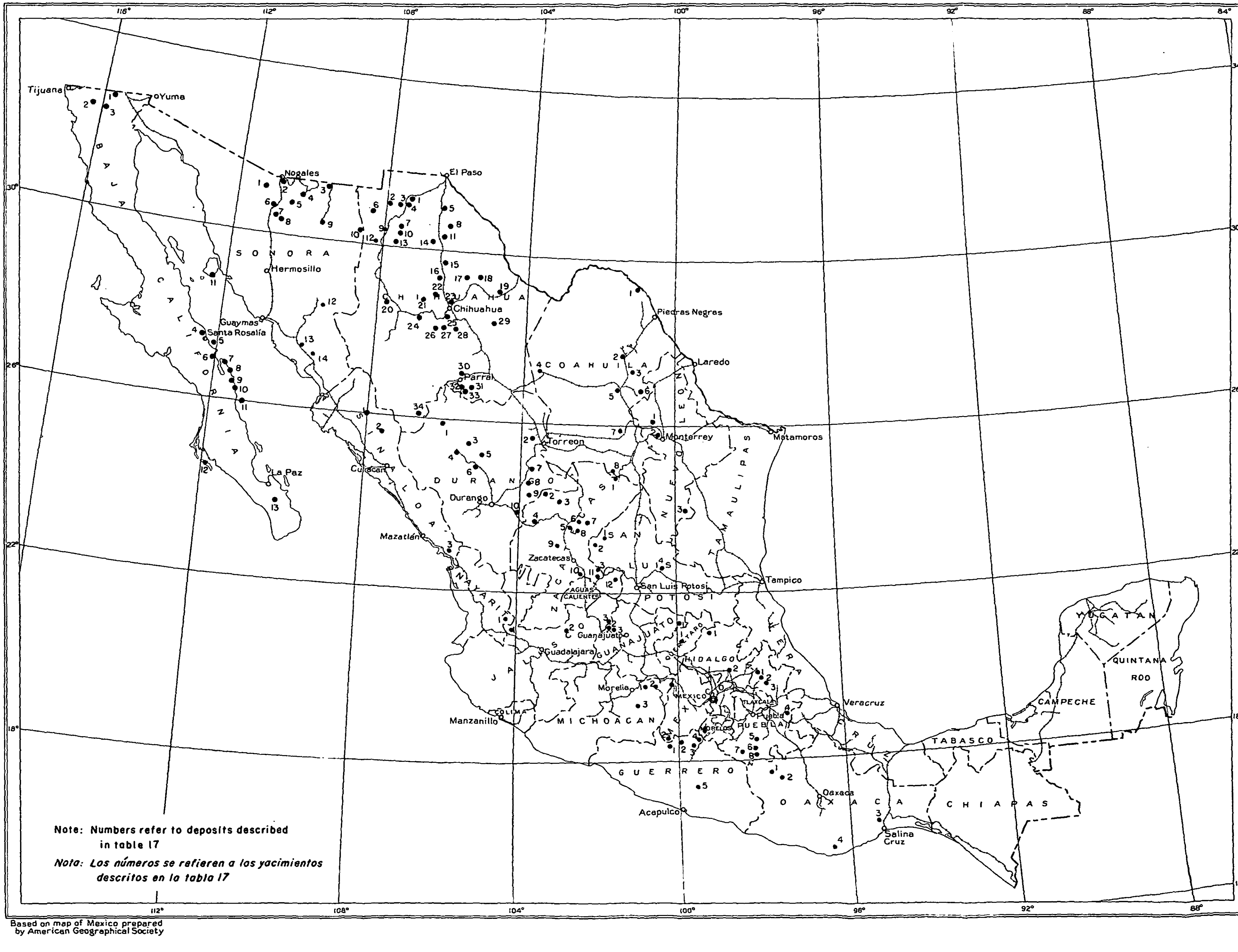
[1] These production figures are based largely on data supplied verbally by owners. At best they are approximations. Figures for Durango include about 1,000 tons produced in April and May 1943, from the Nena (Durango 2e) and Luz (Durango 2g) mines.

Most of the rest of the ore from Mexico was produced during World War I.

With the advent of World War II, the production of manganese ore increased sharply, and the tonnage produced in 1942, as compiled by Wilson from the files of the Foreign Economic Administration and presented in table 1, was approximately 35,000 metric tons, with an average manganese content of about 40 percent. Official records of the Mexican Government for the same year gave a production of only 11,493 tons of metallic manganese, which for an average grade of 40 percent of manganese would correspond to about 28,700 metric tons of ore.

Production during 1943, as compiled by the Foreign Economic Administration, was 70,503 metric tons. This ore averaged somewhat more than 40 percent of manganese. The maximum production in Mexico was reached in 1944, when, according to the Foreign Economic Administration, 80,671 metric tons were produced. This figure refers only to ore exported by Mexico to the United States and does not include ore that was sold to the steel company in Monterrey; nor is it certain whether it includes all the ore shipped to the United States from the Lucifer ore deposit in Lower California.

Ore produced during the early part of World War II, during 1942,



INDEX MAP OF MEXICO, SHOWING DISTRIBUTION OF MANGANESE DEPOSITS

MAPA INDICE DE MEXICO, QUE MUESTRA LA DISTRIBUCION DE LOS YACIMIENTOS DE MANGANESO

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as shown in table 2, came from 15 States: Baja California, with 9,200 tons; Durango, with 8,225 tons; Chihuahua and Zacatecas, each with more than 6,000 tons; San Luis Potosí, with 2,000 tons; Sonora, with 1,200 tons; and Mexico, with nearly 1,000 tons. Minor amounts came from Coahuila, Guanajuato, Guerrero, Hidalgo, Jalisco, Nuevo León, Puebla, and Sinaloa.

The loci of production changed, therefore, with the increased activity brought on by the war. Several of the large producers of earlier years, such as the Montaña de Manganeso (San Luis Potosí 1), Negra (Zacatecas 9), and Antillas (Sonora 6) ore deposits, were largely depleted of visible high-grade ore, and in 1943 were producing at a relatively low rate. A few, such as the Carr (Sonora 3) and Gavilán (Baja California 7) ore deposits, were good producers in 1942. Most of the war-inspired increase of production came, however, from deposits that previously had yielded little or no ore. The principal one of these was the Lucifer (Baja California 4) near Santa Rosalía in Baja California, on the west side of the Gulf of California. This deposit is said to have yielded 9,000 tons of ore in 1942 and has produced at the rate of 1,500 to 2,500 tons a month since then, yielding a total of 87,031 tons up to January 1, 1946. Another good deposit is the Abundancia or Colorado (Zacatecas 7) in north-central Zacatecas, which in the spring of 1943 was producing at the rate of about 1,000 tons a month, and which to May 1944 had produced 12,000 tons of ore.

Total production of manganese ore in México to the end of 1945 was about 292,000 metric tons, which came from some 75 deposits in 15 States, but up to April 1, 1943, only 30 deposits had produced more than 500 tons of ore each.

RESERVES OF MANGANESE ORE

The known reserves of manganese ore in Mexico approximate 1,450,000 metric tons, averaging about 35 percent of manganese and 15 percent of silica. The distribution of these reserves by States is presented in table 3. The figures given in this table are based on the estimates made for the reserves in each of the individual deposits listed in table 18, in which the data presented indicate, at best, only the general size of the deposits, as the ore bodies have been imperfectly explored. These individual estimates were computed from the dimensions of the ore bodies exposed in the existing workings, and from inferences as to the probable continuation of the ore with depth.

The reserves are confined largely to seven States: Baja California, 705,000 tons; Chihuahua, 285,000 tons; Zacatecas, 230,000 tons; Durango, 70,000 tons; San Luis Potosí, 65,000 tons; Sonora, 28,000

TABLE 3.—*Reserves of manganese ore in Mexico, by States*

State	Reserves in metric tons [1]				Number of deposits	
	Deposits visited		Deposits not visited	Total	Total on record	Deposits visited during this investigation
	40 percent of Mn	15–40 percent of Mn	30 percent of Mn	30–35 percent of Mn		
Baja California	[2] 650,000	50,000	5,000	705,000	22	9
Chihuahua		270,000	15,000	285,000	90	52
Coahuila	25,000	1,000	1,000	27,000	18	13
Durango	10,000	50,000	10,000	70,000	39	20
Guanajuato		5,000	1,000	6,000	9	4
Guerrero	2,000	8,000	2,000	12,000	28	11
Hidalgo		1,000	2,000	3,000	2	1
Jalisco		2,000		2,000	14	1
México	10,000	1,000		11,000	10	5
Michoacán			500	500	3	
Morelos			100	100	1	
Nayarit			500	500	2	
Nuevo León			500	500	4	
Oaxaca			500	500	4	
Puebla		5,000	1,000	6,000	12	3
Querétaro			100	100	1	
San Luis Potosí	50,000	5,000	10,000	65,000	10	5
Sinaloa		1,000		1,000	4	
Sonora	10,000	15,000	3,000	28,000	29	13
Zacatecas	140,000	75,000	15,000	230,000	33	16
Total [3]	900,000	490,000±	67,000±	1,450,000±	335	153

[1] Figures indicate general order of magnitude, as most deposits are not developed sufficiently to indicate reliably the amount of ore present.
[2] Includes reserves for the Gavilán deposit (Baja California 7), in terms of concentrate containing 40 percent of manganese.
[3] Total reserves are given in round numbers.

tons; and Coahuila, about 27,000 tons. The rest of the manganese ore is distributed in minor amounts among 13 States. The deposits examined by the writers are divided into two groups: those in which the average manganese content is greater than 40 percent and those in which the manganese content ranges from 15 to 40 percent. The high-grade ore is distributed among the seven States mentioned above, those with the richest ore being Baja California, with 650,000 tons, and Zacatecas with 140,000 tons.

Most of the ore is found in a few large deposits, of which the Lucifer (Baja California 4) near Santa Rosalía, Baja California, is the largest. Others are the Gavilán (Baja California 7) and Talamantes (Chihuahua 31), each of which offers the possibility of yielding more than 125,000 tons of ore or concentrate. The Borregos (Chihuahua 1), Casas Grandes (Chihuahua 9), Zacate-Chino (Chihuahua 27 and 27a), Organos (Chihuahua 29), Candela (Coahuila 6), Montaña de Manganeso (San Luis Potosí 1), and in Zacatecas the Tinaja, Manganita, Abundancia, San Felipe, Tenango, and Negra (Zacatecas 5, 6, 7, 8, 8c, and 9, respectively) ore deposits may have reserves as large as 25,000 tons each, but the rest of the deposits are much smaller.

ECONOMIC FACTORS INFLUENCING PRODUCTION OF MANGANESE ORE IN MEXICO

The main economic factors influencing the production of manganese ore in Mexico are supply and cost of labor, price of product, specifications for marketable ore, cost of transportation, and water supply. The supply of labor is generally not a limiting factor, as sufficient workmen seem available for operating most of the deposits on the scale on which they are being worked. The cost of labor, however, is the most important single factor in mining manganese ore in Mexico, because the ore from practically every deposit must be hand-sorted to bring it up to the desired specifications. Consequently, if the wage scale rose, many mines would not be able to operate profitably unless some cheaper method of mining and sorting could be devised.

The specifications for marketable ore are also an important factor. The ore from practically every deposit has some undesirable impurity or quality that leads to difficulty in its marketing. Even that from the best mine in Mexico, the Lucifer (Baja California 4), contains more than 25 percent of material finer than 20 mesh, which once caused the ore to be rejected by some purchasers, although this difficulty was later overcome by installation of a sintering plant. The Dinamita ore deposits (Durango 2) are mined without sorting and, like the Lucifer, yield a large proportion of fine-grained ore. Moreover, much of the ore from the Dinamita area contains only 38 percent of manganese.

The ore from most of the deposits in Chihuahua and Sonora contains from 25 to 35 percent of manganese, and careful sorting is needed to bring the grade up to 40 percent. In the absence of water, the sorting is done by hand, and if the grade of the ore is particularly low, or if the deposit is far from a railroad, making transportation costly, difficulty is encountered in mining at a profit. During 1942 and the first part of 1943, shortly after the Metals Reserve Co. began purchasing ore, many of these marginal mines were being worked in Chihuahua and Sonora, in the hope that the ore would become better with depth. As these deposits are mainly of the fissure type in volcanic rocks, however, the grade is likely to be best near the surface and to become poorer with depth, owing to the leaching out of the associated calcite. Moreover, as the depth of the workings increases, the cost of lifting the ore to the surface becomes greater. Consequently, even as early as the spring of 1943, scarcely a year after the introduction of the new, higher prices, several mines had ceased to operate.

In central Zacatecas and in the adjoining area in San Luis Potosi, the deposits, though rich in manganese, are high in silica, and much difficulty is encountered in keeping the silica content of the ore below

15 percent. The operators search for pockets of oxide ore to mix with material high in silica. One operator mixed such high-silica ore with low-silica ore from the Dinamita region (Durango 2), with the result that the ore from both places could be marketed at a profit.

Zinc or lead present in ore from a few deposits is a detrimental factor. The ore in the Candela deposits (Coahuila 6) contains more than 40 percent of manganese and can be mined directly without sorting, but the content of lead and zinc combined is more than 2 percent, and in some parts of the deposits as much as 4 percent. Similarly, some of the ore in the Picacho de La Candela deposits (Durango 3) contains a high percentage of lead. The ore in the Protectora deposit (Guanajuato 3) is said to be high in phosphorus, which prevents it from being marketed.

The scarcity of water is also a problem, especially in Sonora and Chihuahua, where the ore is usually found as oxides in fissures. In the deposits in those areas, much country rock is mixed with the oxides, and the ore must be concentrated in order to bring its grade up to 40 percent of manganese. Where water is available, a fair concentration can be effected with jigs. Most of the country is barren of water, however, and the ore has to be sorted by hand. Sea water is expected to be used for concentrating the low-grade ore in the Gavilán deposit (Baja California 7).

Transportation is a serious problem, too. The distances from many mines to the nearest railroads are great, and as many roads are unimproved, the wear and tear on trucks and tires is extremely costly. The Guadalupana mine (Mexico 2), for example, is more than 150 kilometers from the railroad.

The Metals Reserve Co. ceased buying manganese ore in Mexico on June 30, 1945. With the close of hostilities in Europe in May 1945, the way was opened for increased exports to the United States of high-grade ore from countries other than Mexico. These factors, together with the complexities of mining manganese ore in Mexico, are likely to result in a materially lower annual production in the coming years as compared with the period 1942–45, except possibly for ore from the Lucifer deposit in Baja California.

TYPES OF MANGANESE DEPOSITS

FISSURE DEPOSITS

The most common type of manganese deposit found in Mexico consists of fissure fillings. In this type of deposit the ore is mixed with more or less country rock, in fracture zones along fissures and faults. The manganese occurs in the form of black oxides, which are commonly so intimately associated with calcite as to cause this mineral to appear black; from this the name "black calcite" deposit has been used to identify this type of deposit. Calcite is not invariably present, however, and in several areas, as for example in the Gavilán (Baja California 7) and Zacate (Chihuahua 27) deposits, little or none is found. Moreover, the calcite is commonly leached out near the surface of the ground. This causes the ore in the outcrops to be soft and powdery, although in some deposits the upper 2 or 3 meters have been enriched with secondary silica, which makes the outcrops hard and dense.

The ore bodies in the fissure deposits are variable in form and size. They are usually found as lenses or shoots along fracture zones. Some of the mineralized zones can be traced for several hundred meters, although they commonly extend for less than 50 meters. Their width ranges from a fraction of a centimeter to 3 meters, though generally averaging less than 1 meter. Mineralization is commonly more intense at the intersection of fissures, as in the Casas Grandes (Chihuahua 9) deposit, where the ore body is 10 meters wide at the junction of two fissures. One boundary of the fracture zone is generally sharp and fairly smooth, whereas the other is gradational and irregular.

The depth to which the oxide ore extends varies from place to place. In some fissures the ore disappears within 3 meters of the surface, and in others it persists to a depth of 100 meters or more. Consequently, in prospecting for additional ore, or in attempting to estimate reserves, one should recognize the possibility that the manganese ore may not extend far beyond the existing workings. In developing an ore body, therefore, operators should be encouraged either to drift along the vein or to sink on it. As a general policy, tunnelling at right angles to a fissure in order to cut the ore at depth is unwise, unless a shaft has first been sunk on the ore body to ascertain whether or not it extends to the level at which the tunnel is to be driven.

Although the ore is variable in grade, it generally contains from 25 to 35 percent of manganese. Richer ore is found, however, particularly where the host rock has been replaced, but few deposits contain much ore that is richer than 40 percent in manganese. Hence the rock has to be sorted to obtain a product with 40 percent of manganese. In some areas the ore breaks cleanly from the country rock, which makes possible its enrichment by jigging, although the shortage of water generally makes this process impracticable. The ore is usually sorted by hand, commonly to a ratio of two or three parts of mine-run ore to one part of shipping ore.

Chemical analyses of typical ores are given in tables 4 and 5. Table 4 summarizes the general nature of the ore in the Talamantes area (Chihuahua 31), and item 4 in table 5 gives a detailed analysis of the

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ore from the dumps of the San Antonio mine in the same area. Table 6 presents a detailed analysis of a sample of psilomelane from a small vein 150 meters east of the Cuatro Vientos shaft on the San Antonio vein.

TABLE 4.—*Partial chemical analyses of manganese ore from the Talamantes distric (Chihuahua 31)*

Sample	Percent Mn		Percent WO_3		Percent BaO		Percent V_2O_5	Percent insoluble
	Range	Average	Range	Average	Range	Average		
Run-of-mine ore [1]	16.0–44–1	29.9	0.05–1.52	1.00	8.7–9.7	9.2		
Waste dumps [1]	6.3–38.2	24.5	.05–1.27	.55	5.1–10.5	8.0		
Run-of-mine ore [2]		32.0		1.29			0.13	8.23
Shipping ore (sorted)[2]		41.2		1.96				
Waste dump [2]		16.1		.60				

[1] Based on 32 samples collected by P. D. Trask and C. E. Pouliot; analyzed by Michael Fleischer and J. F. Fyfe.
[2] Samples collected by I. F. Wilson and V. S. Rocha; analyzed by Michael Fleischer. (See Wilson and Rocha, 1945.

TABLE 5.—*Partial chemical analyses of manganese ore from four areas in Mexico*

[James F. Fyfe, analyst]

Sample[1]	Metals Reserve Company sample No.	Percent of principal components										Percent of ore finer than 20 mesh
		WO_3	Mn	Fe	SiO_2	Al_2O_3	Zn	Pb	Cu	P	S	
Sarnosa mine (Duranga 2b), Dinamita area	116	1.05	44.1	1.0	1.8	0.06	Tr.[2]	Tr.	0.04	0.02	Tr.	27.6
Lucky Nina mine (Guerrero 5a)	117	.23	35.4	56	16.7	.06	Tr.	Tr.	.04	.02	Tr.	1.2
Milagro mine (Coahuila 6b)	118	.09	50.4	Tr.	5.3	.05	1.8	0	.08	.04	0	.8
San Antonio mine dumps, Talamantes area (Chihuahua 31)	119	1.28	26.6	3.8	36.9	.15	Tr.	0	.13	.03	0	48.2

[1] All are composite grab samples; Nos. 116–118 were taken from stock piles, No. 119 from mine dumps.
[2] Tr. signifies a trace.

TABLE 6.—*Chemical analysis of a sample of psilomelane from the Talamantes district (Chihuahua 31)*

[Michael Fleischer, analyst]

Constituent	Percent	Constituent	Percent	Constituent	Percent
MnO_2[1]	67.91	CuO	0.11	MgO	0.11
MnO[1]	7.62	CoO	.07	CaO	.07
BaO	13.68	PbO	.01	Na_2O	None
H_2O+	5.00	As_2O_5	.36	SiO_2	.14
H_2O-	.90	Fe_2O_3	.20		
WO_3	2.92	P_2O_5	.02	Total	99.69
ZnO	.14	K_2O	.43		

NOTE.—Sp. Gr. (pycnometer) 4.43.
[1] Active O, 12.54 and 12.46 percent; total MnO, 62.82 and 63.24 percent.

The ore minerals consist of both hard and soft oxides of manganese, which contain variable quantities of barium and usually a small percentage of tungsten (table 4). The tungsten content seems to vary roughly with the percentage of manganese, which suggests that tungsten may form part of one of the manganese minerals. X-ray studies by J. M. Axelrod, of the Geological Survey, have shown that cryptomelane, hollandite, and ramsdellite are present. According to Fleischer and Richmond,[1] these minerals have the following compositions: Psilomelane, $BaR_9O_{18}.2H_2O$(?), where R is chiefly Mn^{IV} and to some extent Mn^{II} and Co; cryptomelane, KR_8O_{16}(?), where R is chiefly Mn^{IV} and to some extent Mn^{II}, Zn, and Co; hollandite, BaR_8O_{16}(?), where R is chiefly Mn^{IV} and also Fe^{III}, Mn^{II}, and Co; and ramsdellite, MnO_2. X-ray patterns not characteristic of any known manganese minerals were also found in the Talamantes ore.

Fissure deposits of manganese ore are found principally in northwestern Mexico, and all the many deposits that were visited in the State of Chihuahua, and most of those in Sonora, belong to this type. They are also found, however, in Baja California, northern Sinaloa and Durango, northeastern Jalisco, and central Guerrero. The largest deposits of this type are the Talamantes (Chihuahua 31) near Parral, which are reported to have produced 50,000 tons; those in the Chino and Zacate area (Chihuahua 27 and 27a) southwest of the city of Chihuahua, which have yielded 12,000 tons; and the Borregos (Chihuahua 1) and Casas Grandes (Chihuahua 9) deposits southwest of El Paso, Tex., which yielded 6,500 tons up to the end of 1942, and substantial quantities since then.

A special type of fissure deposit is found in the Gavilan area (Baja California 7) on Punta Concepcion on the Gulf of California. In this area an olivine basalt flow some 23 meters thick has been brecciated and filled with innumerable veinlets of hard black oxides, which are reported to be high in MnO_2 and suitable for battery use. The grade of the ore is low, however, and is estimated to range only from 2 to 10 percent of manganese. The whole basalt flow over an area of some hundreds of meters in diameter is fairly uniformly impregnated with these stringers of oxides. The basalt when crushed breaks rather cleanly from the manganese minerals, which permits concentration by jigging. The deposits are said to have produced some 10,000 tons of ore in the past, much of which is reported to have been of battery grade. In 1945, a plant was being constructed for exploiting the deposits on a large scale.

Reserves of inferred ore in most of the individual fissure deposits

[1] Fleischer, Michael, and Richmond, W. E., The manganese oxide minerals; a preliminary report: Econ. Geology, vol. 38, pp. 272–279, 1943.

range from 200 to 5,000 tons containing 25 to 35 percent of manganese, but some deposits, such as the Casas Grandes (Chihuahua 9) and Borregos (Chihuahua 1) deposits, those in the Chino and Zacate area (Chihuahua 27 and 27a), and the Organos (Chihuahua 29) and Talamantes (Chihuahua 31) deposits, have reserves of more than 25,000 tons each. The Talamantes area, including the dumps, has reserves of more than 125,000 tons. Much larger reserves exist in the Gavilan area (Baja California 7), but the grade of this ore is low.

SILICIFIED REPLACEMENT DEPOSITS

A second common type of manganese deposit in Mexico consists of the replacement of rhyolitic and trachitic tuffs and agglomerates by manganese and silica, in fracture zones along faults and fissures. In some areas this silicification has been so intense that the rocks for distances of several hundred meters have been converted into chert and fine-grained quartzitelike materail. As exposed in outcrops, the silicified zones are commonly elongated, with their long axes two or three times as great as their short axes. Owing to the resistant nature of the silicified rocks, such zones rise from 15 to 100 meters above the surrounding plains. Manganese has been introduced in an irregular way. Most commonly the ore bodies are in the form of chimneys, but in places the mineralization has branched out laterally from the fissures, more or less parallel to the bedding. In many areas iron, also, has been introduced with the manganese.

The grade of the ore in the replacement deposits varies with the type of mineralization. In the better ore bodies, a large tonnage of rock containing more than 40 percent of manganese is present, but the main disadvantage is its high silica content. For example, in the Abundancia mine (Zacatecas 7), run-of-mine ore, as indicated by 10 samples described by Wilson later in this report contains from 35.3 to 52.0 percent of manganese and 4.4 to 23.2 percent of silica. Other undesirable impurities, such as Al_2O_3, Cu, Pb, Zn, and P, are low. Tungsten is present in minor quantities, at most to the extent of only a few hundredths of one percent. Similarly, samples of run-of-mine ore from the Montaña de Manganeso mine (San Luis Potosí 1), described in detail by Wilson later in this report show a range of 35.1 to 50.1 percent of manganese and 11.6 to 37.0 percent of silica.

The ore minerals, as identified by X-ray determinations made by J. M. Axelrod, of the Geological Survey, consist of braunite $3(Mn,Fe)_2O_3.MnSiO_3$, and several manganese oxide minerals, which are mainly pyrolusite MnO_2, cryptomelane KMn_8O_{16}(?), manganite $MnO(OH)$, and pyrochroite $Mn(OH)_2$. Several other manganese compounds not identified with any known minerals are also present. In these deposits, silica is so intimately mixed with the manganese minerals that the resultant mixtures cannot be distinguished from braunite, and as even the braunite is mixed with silica, field identification of the minerals is a problem. Generally, the rocks rich in silica are distinguished from those lean in silica by their splintery fracture, greater hardness, and sharp edges when broken. In some places, bodies rich in oxides and lean in silica are found, which is particularly true in the Abundancia (Zacatecas 7) mine. The ratio of soft oxide ore to siliceous ore ranges, as a rule, from one part in two to one part in ten.

Some 20 replacement deposits of this type are known in north-central Zacatecas and northwestern San Luis Potosí. Others are found near Picacho de La Candela (Durango 3) in northern Durango, and near Arcelia, Guerrero, in the southwestern tip of the State of Mexico (Mexico 2). In the spring of 1943, approximately 25 percent of the production in Mexico came from deposits of this type. The amount of ore in each deposit varies, but in general the reserves approximate a few tens of thousands of tons each.

LIMESTONE-REPLACEMENT DEPOSITS

A third type of deposit consists of the replacement of limestone adjacent to intrusive bodies of granite. Deposits of this kind occur near Dinamita (Durango 2) in northeastern Durango; Buenavista (Guerrero 4) near Taxco, Guerrero; Guadalcazar (San Luis Potosí 4) in eastern San Luis Potosí; and Candela (Coahuila 6) in northeastern Coahuila. The ore is found in both recrystallized and unmetamorphosed limestone. Manganese has been introduced into brecciated zones, where it filled cavities and replaced the limestone. The ore minerals are generally manganese oxides, either with or without interstitial calcite.

The manganese content of the ore varies greatly in these deposits. In most of them it represents less than 25 percent of the rock, and as a result the ore has to be sorted carefully to bring the grade up to 40 percent. In others, especially those near Dinamita (Durango 2), the ore contains from 30 to 45 percent of manganese, and less sorting is required. The principal impurity is calcite, and the silica content is usually less than 5 percent. Analyses of typical ores are given in table 5, items 1 and 3.

Most of the deposits of this type are relatively small, the inferred ore amounting in general to less than 2,000 tons. Only three deposits, the Sarnosa (Durango 2h), Luz (Durango 2g), and Milagro (Coahuila 6b), have reserves of 10,000 tons or more each. The Sarnosa deposit contains pockets of ore as much as 12 meters in length. The ore in such places seems to be in part of secondary origin, for some of the pockets occupy preexisting solution cavities. A large part of this ore is in the form of a fine powder, and in the Sarnosa deposit more than 25 percent of the ore passes through a 20-mesh screen. This ore contains also about 1 percent of tungstic oxide. Several similar deposits are found in limestone near the same granite body, but thus far none have been found that contain pockets as large as those in the Sarnosa and Luz deposits.

In the Milagro deposit (Coahuila 6b) in northeastern Coahuila, the ore is found along the lower contact of nearly horizontal sills of granite porphyry intruded into limestone. It forms flat beds from 0.3 to 2 meters thick that contain from 40 to 45 percent of manganese. Assays of the ore show consistently 2 percent of zinc and as much as 2 percent of lead. In one place the manganese oxides grade into a zone containing 20 percent or more of galena and alabandite, the manganese sulfide. This deposit has no appreciable content of tungsten.

Some deposits of a similar character, but in brecciated zones in limestone far from any known body of granite, should perhaps also be included with this type of deposit. Three of these—one near Múzquiz (Coahuila 2) in northern Coahuila, a second near Hipólito (Coahuila 7) in south-central Coahuila, and a third near San Pedro Ocampo (Zacatecas 1) in northeastern Zacatecas—contain braunite(?) besides manganese oxides.

The ore mined from these replacement deposits in limestone constituted about 10 percent of all the manganese ore produced in Mexico in the spring of 1943. Production at this rate could be maintained only by a continued discovery of new pockets in existing mines in this type of deposit.

TUFF-REPLACEMENT DEPOSITS

The largest manganese deposit in Mexico, the Lucifer (Baja California 4), is a siliceous and manganiferous replacement of tuff, and except for a few minor deposits nearby, it is the only one of its kind in Mexico. The deposit has been described in detail by Wilson and Veytia (1947). The ore is found in well-stratified tuffs that rest on volcanic agglomerate; the thickness of the ore body ranges from 1 to 6 meters, averaging 3 meters. The deposit has been well explored by an elaborate series of drifts and crosscuts in an elliptical area 450 meters long and 50 to 130 meters wide.

The ore is confined essentially to the tuffs, and in places it contains unreplaced lenses of tuff from 2 to 10 centimeters thick and several meters in diameter. In a few places the tuff has been silicified, forming zones locally called "huesos," but in general the ore is very low in silica. The manganese content of the ore body ranges from 37 to 57 percent; the average of all samples collected by Wilson was 48 percent. The principal ore minerals are cryptomelane KMn_8O_{16}(?)

and pyrolusite MnO_2. The percentages of the minor constituents and impurities in the ore, as reported by Wilson and Veytia, are given in tables 7 and 8. The deposits are described in detail in another section of this report.

TABLE 7.—*Chemical analyses of minor constituents and impurities in the Lucifer (Baja California 4) ore*

[Analyses of O, SiO_2, NaCl, Fe, BaO, Pb, Cu, and V_2O_5 were made by the Geological Survey; remaining data were supplied by Sres. Mahieux and García Quintanilla]

Constituent	Percent			Number of analyses
	Range		Average	
	Low	*High*		
O	12.93	14.82	14.02	8
H_2O	.16	13.60	8.21	30
SiO_2	.27	[1] 31.3	[1] 4.47	15
Al_2O_3	.13	4.21	1.73	23
NaCl	Trace	4.85	1.22	15
CaO	.25	2.10	1.10	9
Fe	.75	2.12	1.10	8
BaO	.06	1.62	.86	7
MgO	.18	1.50	.83	5
Pb	.01	1.74	.59	15
Cu	.11	.71	.28	15
V_2O_5	.08	.22	.14	7
Zn	.01	.19	.11	44
S	.02	.20	.11	25
P	.02	.11	.05	49
CO_2	.65		----------	1
Co	None	.098	----------	3
Mo	.081		----------	1
Sb	.024		----------	1
Ni	None	.003	----------	3
As	Trace	.01	----------	2
Ag	Trace		----------	1

[1] If the sample of "hueso" (31.3 percent) were excluded, the average SiO_2 content would be 2.57 percent.

TABLE 8.—*Spectrographic analysis of a composite sample of Lucifer (Baja California 4) ore*

[Spectrographic examination by K. J. Murata, of a composite sample of manganese ore made up of eight samples collected by I. F. Wilson from various parts of the mine]

Relative order of percentage	Elements	Relative order of percentage	Elements
1 percent or more	Mn, Si, K, Na, Fe, and Ba.	Looked for but not found.	As, Sb, Bi, Zn, Cd, Rb, Cs, Ni, Ga, In, Sn, Ge, Au, Pt, Pd, W, Ag, Re, Th, Cb, and Ta.
0.X percent	Pb, Cu, Ca, Al, and Mg.		
0.0X percent	V, Mo, Co, and Sr.		
0.00X percent or less	Tl, Ti, Cr, and Li.		

The Lucifer ore deposit was first mined in 1942. The rate of production has depended to a large extent on shipping facilities and market conditions, and at times has exceeded 2,500 tons a month. Production up to January 1946 amounted to some 87,000 tons. The operators have developed the mine by means of a series of intersecting drifts and crosscuts, leaving pillars of ore that contain larger quantities than those mined. In 1945, the limits of the deposit had not yet been reached. The ore body extends under a lava-capped mesa, where it was found to be thicker as exploration progressed. The Lucifer is probably the best manganese mine in North America. The only draw-back is the high proportion of fine material contained in the ore, but a sintering plant has been built to overcome this defect.

MISCELLANEOUS DEPOSITS

The four types of deposits described above yielded more than 95 percent of the manganese ore produced in Mexico during the years 1942–45. The remaining 5 percent came from several different kinds of deposits, in most of which the reserves are very small.

The most productive of these miscellaneous deposits was that of the Carfos Co. (Sonora 3), located some 20 kilometers southwest of Douglas, Ariz. This deposit is found in a circular down-warped or down-faulted block some 150 meters in diameter. The ore occurs in sedimentary rocks, in three zones within a stratigraphic interval of 30 meters. Some of the beds are replaced by manganese and others are not. In each zone an aggregate of from 30 to 100 centimeters, out of a total thickness of 2 meters, consists of siliceous manganese ore containing from 40 to 42 percent of manganese and from 8 to 13 percent of silica. The manganese mineral looks like braunite. Some 3,300 tons had been produced from this deposit up to March 1943, of which 2,120 tons was extracted during World War I.

Another type of ore deposit is found in Guanajuato (Guanajuato 2 and 3), where lenses of manganese oxides occur in slaty shale. Near the surface these bodies are altered to oxides, but in one deposit, the Protectora (Guanajuato 3), the oxide ore gives way with depth to moderately fine grained rhodonite; and the others presumably do likewise. The Protectora deposit is said to contain 4 percent of phosphorus. The ore bodies in these deposits are lenses, none of which is over 30 meters long and 1 meter thick. Reserves in the individual lenses are therefore not very large. The Protectora deposit is located within 100 meters of a mass of granite; the others are cut by quartz veins, but no granite was seen near them.

Still another type of ore deposit (Puebla 8) is found near the town of Acatlán, in southeastern Puebla. This deposit consists of three lenticular bodies of manganese oxides and braunite, found at intervals of about 100 meters along a single stratigraphic zone in schist. The ore is intersected by numerous veinlets of quartz and has to be sorted carefully to bring the manganese content up to 40 percent. The length of the longest ore body is 30 meters, and the thickness of the largest is 6 meters. The average thickness of all the bodies is only 2 meters. A large tonnage of high-grade ore is therefore not to be expected.

A deposit (Sonora 5) of coarsely crystalline pink rhodochrosite ($MnCO_3$) is located near Magdalena, Sonora. Most of the pink crystals of rhodochrosite range from 1 to 3 centimeters in diameter. The ore is said to be nearly pure and to be suitable for chemical purposes. It is found in veins in argillite, in places associated with stringers of granitic rock. The rhodochrosite is mixed with quartz, calcite, and a variable proportion of metallic sulfides. The best ore contains about 50 percent of rhodochrosite. The veins vary in width mainly from 15 to 50 centimeters and in length from 15 to 50 meters. The total production from the deposits is said to have been 500 tons of chemical-grade ore. Reserves of minable ore are relatively small.

An unusual type of deposit (Guerrero 5) is found 40 kilometers south of Chilpancingo, in southern Guerrero, where manganese is encountered in veins of johannsenite, a complex silicate of manganese, in massive limestone. These veins are nearly vertical and vary in width from 1 to 3 meters and in length from 3 to 50 meters. Near the surface the johannsenite has been partly leached out and the ore consists of an oxidized residue that retains the peculiar radiating crystal form of the primary mineral crystals. The oxidized ore contains from 25 to 30 percent of water, 16 percent of silica, and about 0.25 percent of tungstic oxide. (See table 5, item 2.) This ore resembles wad and, according to X-ray determinations by J. R. Axelrod, has no distinctive crystal pattern, although it has the appearance of a crystalline substance because of its relict structure. Difficulty is encountered in sorting the rock to obtain a product with 40 percent of manganese, and because of this no ore has been marketed. Moreover, the primary johannsenite, with its high content of silica, is found from 1 to 10 meters below the outcrops.

A deposit (Nayarit 1) located near Hostotipaquilla, in southeastern Nayarit, is said to consist of stringers of manganese oxides in schist. Owing to its remoteness, this deposit has produced little ore and was not visited.

Manganese has been reported from several lead mines in Mexico, either in gangue minerals or in chemical combination with the lead itself. As lead is an undesirable impurity in manganese, these mines are not now producing manganese ore.

An interesting deposit (Chihuahua 32g) located south of Parral, Chihuahua, was visited by D. E. White (38), who reports that the ore consists of rhodochrosite, manganese oxides, stibnite, and chalcedonic quartz, in a vein cutting siliceous and calcareous shales. The manganese content is estimated to be less than 30 percent.

On San Marcos Island (Baja California 5), 25 kilometers southeast of Santa Rosalía, Baja California, manganese oxides occur as veinlets, nodules, and irregular masses penetrating a flat-lying fossiliferous sandstone, according to I. F. Wilson (39). As seen in the face of a cliff in one part of the deposit, the ore appears to extend only through

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the upper half meter or meter of the sandstone. A similar deposit, the San Juanico (Baja California 9a), is situated southwest of Punta Púlpito, where manganese oxides occur as veinlets and pockets in a nearly flat lying sandy limestone. In both these deposits the ore is of low grade and the reserves are small.

DESCRIPTIONS OF INDIVIDUAL DEPOSITS

The following sections present detailed descriptions of the manganese deposits examined in the field by the authors. Summary descriptions prepared by Ivan F. Wilson are given of the Baja California, Talamantes (Chihuahua 31), Montaña de Manganeso (San Luis Potosi 1), and Abundancia (Zacatecas 7) deposits. After the authors' visit, these areas were studied in greater detail by Wilson with Mario Veytia and Victor S. Rocha; the findings are described in separate published reports. Little material is given in the text, however, for deposits not visited, but most of the information that could be obtained about them is presented in table 17. The numbers after the names of the persons cited in the following descriptions and in table 17 refer to the list on page 170 and those after the names of the mines and deposits refer to the map in plate 39 and to table 17.

BAJA CALIFORNIA [2]

LUCIFER MINE (4)

The Lucifer mine, 17 kilometers northwest of Santa Rosalía and about midway along the west coast of the Gulf of California, is the largest producer of manganese ore in Mexico and seems to contain the largest deposit of high-grade manganese oxide ore known to exist in continental North America. The mine is located 8 kilometers inland from the Gulf, on the north side of Arroyo del Infierno and 150 meters above the valley floor. Ore is lowered to the arroyo by a gravity tram and transported by truck and rail to Santa Rosalía, which serves as headquarters for Boleo copper mines. From Santa Rosalía the ore has been shipped to San Pedro, Calif., as well as across the Gulf of California to Guaymas, Sonora, and through the Panama Canal to Atlantic coast ports.

The deposit lies at the north end of the Boleo copper district, and although two tunnels were driven into the outcrop about 30 years ago in search of copper, no manganese ore was mined until late in 1941. Ore was first produced in 1942 by the partnership of Mahieux y García Quantanilla, S. en N. C., and in the 4 years from then until January 1, 1946, the deposit yielded 87,031 tons of high-grade manganese oxide ore. Most of the ore first mined was shipped to the Iron and Steel Division of the Kaiser Co., located in Fontana, Calif.

[2] Description of deposits in Baja California has been written by Ivan F. Wilson and Mario Veytia.

Later, shipments were made to other steel companies, and some ore has been shipped for chemical purposes to the Tennessee Eastman Corp.

The manganese deposits, along with the Boleo copper deposits, are enclosed in beds of tuff intercalated with conglomerate, which form part of the Boleo formation of lower Pliocene age. This formation unconformably overlies tilted and faulted volcanic and pyroclastic rocks of the Comondú formation of Miocene age and is overlain by middle and upper Pliocene and Pleistocene marine sediments and Pleistocene or Recent lava flows. The volcanics of the Comondú formation are cut by normal faults with displacements of from 50 to 100 meters, whereas the later sediments are cut by faults that in general have displacements of 10 meters or less. The main period of deformation was at the close of the Miocene, although minor faulting and tilting continued through the Pleistocene. The Boleo formation was deposited on a surface of strong relief, and its structure shows the influence of high initial dips and differential compaction around hills and ridges formed of the volcanic rocks of the Comondú formation.

The ore body in the Lucifer mine is a gently dipping deposit that lies roughly parallel to the bedding of the enclosing tuffs. It has been blocked out by intersecting drifts over an area 450 meters long and from 50 to 130 meters wide—as of May 1946—in which its thickness ranges from 1 to 6 meters, averaging 2.5 to 3 meters. Ore is being followed by means of drifts driven to the west and northwest, below a lava-capped mesa, in which direction its extent is not known. The main ore body is in a structural terrace that trends west-northwest. In the southwestern part of the mine, the ore turns up steeply and pinches out against a projecting ridge of the volcanic rocks of the Comondú formation. A comparison of a structure-contour map of the base of the ore with an isopach map showing the thickness of the ore reveals that the axis of greatest thickness follows fairly closely the trend of the structural terrace. The ore is thickest in synclines developed in the terrace and thins out over a hump. A gently dipping fault, which may be premineral, overlies the ore, from which it is separated in many places by a thin wedge of tuff, although in some places a thin zone of ore occurs above the fault. The ore is offset by a few steeply dipping normal faults, the largest of which has a displacement of about 8 meters; two others have displacements of 4 meters and 6 meters.

The ore consists mostly of incoherent fine-grained black manganese oxides, which on mining break up into small particles, resulting in a product that contains an average of 30 percent of material finer than 20 mesh. The only troublesome feature of the ore for metallurgical use is the high content of fines, but this defect was remedied by a sintering plant that was installed in 1945. The manganese minerals are cryptomelane and pyrolusite. Within the soft fine-grained ore are lenses of a hard siliceous ore, called "hueso," and a few lenses of hematitic and limonitic jasper. The soft ore contains 45 to 50 percent of manganese and less than 5 percent of silica. Certain portions of it that contain a large percentage of pyrolusite are suitable for chemical use, and some ore has been mined selectively for that purpose. The lead content, about 0.6 percent, and copper content, about 0.3 percent, are too high to permit using the ore in batteries but are within the limits permitted for metallurgical and chemical purposes. The ore contains an average of 1.2 percent of sodium chloride.

Other manganese deposits are scattered over an area extending 4 kilometers north and 4.5 kilometers southeast of the Lucifer mine, but without exception they are small, thin, of lower grade, and apparently of little commercial value. They occur at two, or perhaps three tuff horizons in the Boleo formation. Some of them have been worked by "gambusino" operators. The total production from all the deposits to the end of 1943 was 1,100 tons, which is included in the production figure given for the Lucifer deposit; very little ore has been produced since then. These deposits are covered by 36 claims owned by Mahieux y García Quintanilla, S. en N. C. The deposits are divided into two groups—the Lucifer and Navidad. The Palmas deposits, at the north end of the Lucifer deposits, and the Navidad deposits are described briefly in later sections in this report.

The manganese deposits are believed to have been formed by hydrothermal solutions, which rose along faults in the volcanics of the Comondú formation and spread out along the beds of tuff in the Boleo formation. The ore was probably deposited fairly near the surface. Evidence in favor of this theory of origin includes (1) the presence of veinlets and veins of manganese oxides—along with copper minerals, iron oxides, and jasper—in the underlying volcanic rocks of the Comondú formation; (2) the accompaniment of the ore by jasper, which has replaced various types of rocks; (3) the crosscutting relationships of the veins to the bedding; (4) the irregular distribution and localization of the deposits in the district; and (5) the indication of structural control of deposition in the main Lucifer ore deposit and in some of the smaller deposits. The mineralization probably occurred near the end of early Pliocene time, perhaps during a late phase of the same volcanism that gave rise to the tuffs of the Boleo formation. The Boleo copper deposits are believed to have been formed at about the same time and in the same manner as the manganese deposits, although they occur mostly in an area south of the Lucifer district.

Aside from the ore in the blocked-out area, of which about 30 or 40 percent had been removed by May 1946, the future possibilities of the mine seem to depend on how far the ore body extends to the west-northwest, beneath the lava-capped mesa. The geologic conditions seem favorable for a continuation in that direction, and drilling from the mesa would provide the answer at a relatively low cost.

The future of the Lucifer mine will depend mainly on the cost of transportation and the market for manganese ore. The most disadvantageous condition is the location of the mine away from any of the main shipping routes to the Atlantic coast ports, a condition that applies, of course, to all the manganese mines in Mexico. Considering only geologic factors, the present production rate could probably be maintained for at least 5 years and perhaps 10 years or more, but more definite figures should await the results of further underground exploration or drilling from the mesa west of the mine.

Navidad group of deposits (4a).—The Navidad group of claims includes several small deposits in Arroyo del Boleo and Cañada de La Gloria, south of Arroyo del Infierno. Most of the deposits are found within an area of about 1.5 square kilometers, extending 4.5 kilometers southeast of the Lucifer mine. Production, which amounts to a few hundred tons, has been included with that of the Lucifer mine. Open-cuts, short drifts, and room-and-pillar stopes have been made at various places by "gambusinos."

All the Navidad deposits are smaller, thinner, and for the most part lower in grade than is the Lucifer. In most of them the ore body is less than 1 meter thick and wedges out within a distance of 20 meters. In many places the ore consists of patches, veinlets, and irregular masses of manganese oxides that penetrate the tuffs, as in the Palmas ore deposits below. It occurs at least at two horizons in the tuffs, and in places it is closely associated with beds that contain co pper ore. In other places a fossiliferous tuffaceous limestone member of the Boleo formation is impregnated with manganese oxides, and molds and casts of pelecypods and gastropods are replaced by these oxides.

The economic possibilities of the Navidad deposits lie solely in supplementing the ore produced from the Lucifer mine. Work on this group had been abandoned in 1945 and 1946.

Palmas deposits (4b).—The Palmas deposits are located on both sides of Arroyo de Las Palmas, 4 kilometers north of the Lucifer mine. They are included within the Lucifer group of claims owned by Mahieux y García Quintanilla, S. en N. C., although they were formerly owned for a time by a Sr. Echevarría.

The deposits occur at scattered localities at two horizons in the tuffs of the Boleo formation. "Gambusinos" have opened a few cuts and short drifts, and in places have stoped out small quantities of ore by a room-and-pillar system, as in the Lucifer mine. The ore bodies are thinner, more irregular and lower in grade than those in the Lucifer mine. Most of them are less than 1 meter thick and contain many lenses of tuff.

Some of the deposits consist merely of pockets, veinlets, or irregular masses of manganese oxides that penetrate tuff and tuffaceous conglomerate. Crosscutting relationships to the bedding are clearly shown. On the south side of Arroyo de Las Palmas, a 1-meter layer of manganese ore extends for a distance of several meters from the tuff into an underlying gypsum bed.

The production from the Palmas deposits is included with that from the Lucifer mine, and although not known exactly, has not amounted to more than a few hundred tons. Some of the deposits, including one on the north side of Arroyo de Las Palmas, had been completely worked out by August 1944, and all the deposits were abandoned during 1945 and 1946. Much of the ore in these deposits contains gypsum, which probably increased the sulfur content of the Lucifer ore when mixed with it. The Palmas deposits are not promising and might be expected only to supplement the production from the Lucifer mine with a small amount of ore.

EUREKA CLAIM, ISLA SAN MARCOS (5)

A small manganese deposit has been found in the Eureka claim on Isla San Marcos in the Gulf of California, 25 kilometers southeast of Santa Rosalía. Extensive gypsum deposits on the south end of the island have been mined for several years by the Cía Occidental Mexicana, S. A.; a wharf and village are situated on the southwest side of the island.

The manganese deposit is in the east-central part of the island, on a small mesa called Mesa de Las Chivas. This is a short distance southeast of the highest point on the island, which has an altitude of 272 meters. The manganese deposit was operated for a short time by Mr. M. F. de Lara of San Francisco; it is reported that, in 1942, two carloads of ore were shipped that did not meet the specifications established by the Metals Reserve Co. The ore was carried on burros to the east short of the island, about 3 kilometers distant, and from there by boat to Guaymas, Sonora. Only a few small shallow cuts were dug, and the property was idle in 1943 and 1944.

The northwest half of Isla San Marcos is composed of tilted volcanic and pyroclastic rocks of the Miocene Comondú formation. These rocks are overlain unconformably by tuff, conglomerate, and intercalated gypsum beds, similar to the lower Pliocene Boleo formation of the Lucifer district. These beds dip to the southeast, in a broad plunging anticline. The small mesa on which is the manganese deposit is formed of nearly flat lying beds of fossiliferous calcareous sandstone and conglomerate, which overlie unconformably the tuff and conglomerate correlated with the Boleo formation. The age of the sandstone may be middle or upper Pliocene. Small lava caps, probably equivalent in age to the Tres Vírgenes volcanics (Pliestocene or Recent) of the Lucifer district, are found in the eastern part of the island.

Manganese oxides occur as veinlets, nodules, and irregular masses penetrating the fossiliferous sandstone. They include both soft crystalline pyrolusite and hard botryoidal material of the psilomelene type. In places, molds and casts of fossils, mainly pectens, have been replaced by manganese oxides. The veinlets and masses of manganese oxides are concentrated along joints and fissures that have a northerly trend. The occurrences are scattered over an area about 400 meters long in a northerly direction and are from 25 to 100 meters wide. Individual areas where veinlets and masses of manganese oxides are concentrated, however, rarely have a length of more than 10 meters or a width of more than 1 meter. The sandstone bed has a thickness of 2 to 6 meters, but apparently only the uppermost meter or half meter contains an appreciable proportion of manganese oxides, as in a cliff face at the north end of the deposit. The material in which the manganese oxides are most highly concentrated is estimated to contain 25 or 30 percent of manganese.

The Eureka claim is not a particularly promising source of manganese ore because of the scattered occurrence of the ore, its low grade, and the fairly small extent of the deposit.

AZTECA DEPOSITS

The Azteca deposits are about 10 kilometers by trail north of Mulegé and approximately 5 kilometers inland from the Gulf of California. They are in a mountainous region of fairly strong relief. The mine workings are on the sides of two ravines and along a steep hill between them. The deposits were worked for a time in 1940 by Mr. Henry Allen, and several open-cuts and short drifts were made. Some ore was sacked at the mine and carried on burros to the shore, but none was shipped, probably because of its low grade. The deposits were then abandoned and have not since been worked.

The rocks in the region belong to the Comondú formation of Miocene age, except for some younger gravels that cap the high mesas. The manganese deposits are in an orange volcanic rock, probably andesitic in composition. The deposits consist of narrow veins of manganese oxides accompanied by large quantities of white calcite, which in places forms from half to nearly the whole width of the veins. The calcite is in part coarsely crystalline and in part fine-grained and banded; it is white to gray and is stained green in places. Most of the manganese oxides are of the hard botryoidal psilomelane type, accompanied by a small amount of soft black oxides. The average ore mined is estimated to contain 25 or 30 percent of manganese. The main vein is exposed at intervals for about 15 meters. It follows a brecciated fault zone in the volcanic rocks, and in places is bounded by a fairly smooth footwall. Its strike is northwest and its dip is 60°–70° NE. The vein ranges in thickness from 10 centimeters to 2 meters, but as it is composed partly of calcite, the actual thickness of the manganese oxides is much less, certainly no more than 20 centimeters. In the surrounding area thin veinlets of manganese oxides occur along joints and fissures, just as they do in the Gavilán deposit (7), but the spacing is not sufficiently close to permit excavating the wallrock on a large scale, as planned at the Gavilán. Furthermore, the grade of the manganese oxide ore within the veinlets is less than at the Gavilán.

The Azteca deposits are not believed to be of commercial importance because of the low grade of the ore and narrowness of the veins.

GAVILÁN ORE DEPOSITS (7)

The Gavilán deposits on Punta Concepción Peninsula, which were noted as early as 1892, have aroused considerable interest, both during World War I and at intervals since then (Halse, 1892; Wallace, 1911a, 1911b, 1916; McQueston, 1917; and Antúnez Echegary, 1943, 1944). The deposits are on the northeast side of the peninsula, 20 kilometers east of Mulegé on the Gulf coast of Baja California. The principal mine is along the seashore, about 3 kilometers southeast of Concepción. It is reached by small boats from Mulegé, which is 60 kilometers by road south of San Rosalía. Boats cross Concepción Bay to a small landing called Guadalupe, where a dirt road 10 kilometers long leads across Punta Concepción Peninsula to the mine. Ore has been shipped in small boats from Guadalupe across the Gulf of California to Guaymas, Sonora. Some ore was shipped during World War I, mostly from float along the beach. In World War II, mining was begun by "gambusinos," who worked in open-cuts. No figures are available for production during either of the two wars, but probably a total of a few thousand tons of ore was shipped.

In 1942, the property was taken over by the Cía. Mexicana de Manganeso, S. A., which in 1944 constructed a mill to concentrate the ore. The ore occurs as innumerable thin veinlets of manganese oxides in basalt, and it was planned to excavate a large volume of rock by surface stripping and to extract the veinlets of manganese oxides by grinding and wet jigging, using sea water. Such an operation, if successful, would probably be unique in the field of manganese mining. By early 1946, the mill had not yet been placed in successful operation, although experimental work was continuing. Various difficulties resulted from the very low average grade of the manganese-bearing rock and the use of sea water in the jigs, as well as from the inherent difficulties involved in the mechanical concentration of manganese ores. Most of the production of this company to 1946, therefore, had not come from the large-scale operations originally planned, but from small bodies of high-grade ore mined by hand from open-cuts in the larger veinlets. This ore has been sold for chemical purposes and has been shipped to the Tennessee Eastman Corp.

The rocks in the vicinity of the mine consist mainly of flows, agglomerates, breccias, tuffs, and intrusive rocks of basaltic to andesitic composition, which are correlated with the Comondú formation of Miocene age. A tuffaceous conglomerate rests unconformably upon the volcanic series south of the mine, and fossiliferous marine strata, probably of lower Pliocene age, occur in narrow belts along the shore on the west side of Punta Concepción. Cerro del Gavilán, the chief area mined, is composed of two flows of olivine basalt, underlain by agglomerate and tuff. The top of the lower flow is marked by a weathered, reddish to purplish, crumbly, scoriaceous zone, half a meter to 2 meters thick. According to thin-section studies by Noble (22), both flows contain phenocrysts of plagioclase, olivine, and augite in a fine-grained granular groundmass. The upper flow has a brownish color and is 35 meters thick; the lower flow is lighter-colored and only 25 or 30 meters thick. The underlying beds range from agglomerate to well-bedded sandy or clayey tuff.

Northwest of Cerro del Gavilán a valley has been eroded in the tuff, and the mill was built in this valley. The basalts reappear 200 meters to the northwest, in a series of hills terminating 800 meters northwest of Cerro del Gavilán, at Punta Gato, where six flows of basalt have been recognized by Noble. The flows on Cerro del Gavilán and Punta Gato strike N. 20°–30° W. and dip 15°–25° NE., toward the Gulf. They are cut by normal faults that strike northwest and dip mainly 50°–70° SW., along which the northeast sides are upthrown from 1 to 10 meters.

The ore deposits consist of a series of veinlets and stringers of manganese oxides that cut the basalts. The average strike of the veinlets is N. 20°–25° W. and the dip is 50°–70° SW. A less prominent group of veinlets strikes N. 50°–90° W. and dips 50°–70° NE. to N., and other veinlets have various attitudes. The veinlets tend to branch, reticulate, and change along both the strike and dip. Most of them are from 1 to 10 centimeters thick, but along fault zones some larger veins half a meter or more in thickness are found. Some of the larger veins are along brecciated zones in which manganese oxides cover fragments of the breccia. The spacing between the veinlets is highly variable, but within the main ore-bearing areas in the upper basalts of

Cerro del Gavilán and Punta Gato, it ranges in general from a fraction of a meter up to 2 or 3 meters. The veinlets are more numerous along fault zones.

The ore within the veinlets consists of massive, nearly pure, black manganese oxides. It breaks readily from the wall rock, owing perhaps to the presence of thin selvages of clay, which facilitates hand sorting. The ore as sorted contain 76 to 80 percent or more of manganese dioxide and is suitable for chemical purposes. Some specimens sent to the Geological Survey by J. A. Noble were identified by X-ray methods by J. M. Axelrod, who found that the massive black oxides were hollandite,[3] and that small crystals lining vugs in this material were ramsdellite (MnO_2). These specimens, however, were not thought to be characteristic of the deposit as a whole. The manganese oxides are accompanied in places by aragonite, iron oxides, fine-grained quartz, minor quantities of calcite and dolomite, and, in one locality, crystals of vanadinite.

The areas in which large-scale excavations have been contemplated are on the two hills, Cerro del Gavilán and Punta Gato, where the manganese oxide veinlets are in the upper basalts and are most closely spaced. The upper basalts on Cerro del Gavilán are exposed in a roughly triangular area whose dimensions are about 400 by 300 meters, and the average thickness of basalt left by erosion is about 20 meters. The area occupied by the upper basalts on Punta Gato is about 600 meters long and 80 to 200 meters wide, and the average thickness of the basalts, down to sea level, is about 20 meters.

If the milling method should prove successful and permit large-scale surface mining of all the rock, as was originally planned, the Gavilán mine would yield fairly large quantities of manganese oxide concentrate for several years. Early in 1946 it was not yet clear whether this could be accomplished. If the milling method should not be successful, only a small production could be expected from the mining and hand-sorting methods so far used, owing to the narrowness of the individual veinlets.

Guadalupe deposits (7a).—The Guadalupe deposits are located on the west side of Punta Concepción peninsula, some 12 kilometers southwest of the Gavilán deposits and 3.5 kilometers southeast of Guadalupe landing. A few open-cuts were made during World War I, but the production, if any, was very small, and the deposits were not being worked in 1943 and 1944. They were not visited by the writers, but were described by Halse (1892), Wallace (1911c, 1916), McQuesten (1917), and Antúnez Echegaray (1944).

3 Composition of hollandite: BaR_8O_{16} (?), R=Mn^{IV} chiefly, also Fe^{III} and Co. See Fleischer, Michael, and Richmond, W. E., The manganese oxide minerals; a preliminary report: Econ. Geology, vol. 38, p. 274, 1943.

From these descriptions it is gathered (1) that the deposits consist of six or seven northwestward-trending veins, mostly less than half a meter thick, in altered basalt and red basaltic tuff; (2) that the veins consist of manganese oxides accompanied by much gypsum, along with calcite, iron oxides, chalcedony, and quartz; and (3) that superficial concretions and films of manganese oxides have given a misleading impression as to the extent of the ore. The ore in the veins is of low grade; the average of seven assays reported by Wallace is 17.54 percent Mn, 1.63 percent Fe, 3.61 percent CaO (as sulfate), and 28.22 percent SiO_2.

The deposits are thought to have little commercial value because of the low grade of the ore, the abundance of gypsum, the tendency of the ore to diminish with depth—according to Antúnez Echegaray—and the thinness of the veins.

SANTA ISABEL (SAN NICOLÁS) DEPOSIT (9)

The Santa Isabel deposit, known also as the San Nicolás, is on the south side of Arroyo de San Nicolás, about 7 kilometers inland from the village of San Nicolás on the Gulf of California and opposite Isla Ildefonso. The nearest road is about 15 kilometers by trail southwest of the deposit, at the ranch known as Rosarito, on the Mulegé-Comondú road about 15 kilometers southeast of Concepción Bay. Several open-cuts were made during World War I; the largest is a trench about 60 meters long (discontinuous) and 1 to 5 meters deep. Ore was hauled on burros to San Nicolás, where it was loaded into boats. The production is not known but is believed to be small. In January 1944 there was no evidence of any new work at the deposit.

The deposit consists mainly of a single vein of manganese oxides cutting a reddish volcanic conglomerate, a member of the Miocene Comondú formation. The vein occurs along a northward-trending fissure that is traceable at intervals for more than 200 meters. In the northernmost exposure the fissure strikes N. 10° E. and dips 50° W. Farther south, the strike is N. 20° E. and the dip is vertical, and near the south end the strike swings around to N. 15°–20° W. and the dip ranges from 80° E. to vertical. The thickness of the vein as now exposed ranges from 1 to 30 centimeters and, in general, averages 10 or 15 centimeters. Some of the trenches are half a meter wide, but as the bottoms are filled with debris it is not known whether the ore originally had this thickness. The depth to which the vein extends is likewise unknown; the deepest trench is about 5 meters deep, but whether the ore continues in the bottom is not known. The fissure is followed in part by a single well-defined vein, but in places this splits and branches along its length into several veinlets.

The manganese oxides consist of hard black botryoidal material of the psilomelane type and are accompanied by veinlets of calcite and orange opal. The soild veins of manganese oxides probably have a manganese content of about 45 percent. Smaller, scattered veinlets, most of which are only 3 or 4 centimeters thick, are found in the hills as much as 1 kilometer south of the main deposit.

Although a small amount of manganese oxide ore of fairly high grade could perhaps be obtained, the Santa Isabel deposit is believed to have slight commercial importance because of the narrowness of the veins and the relative inaccessibility of the locality.

San Juanico deposit (9a).—The San Juanico deposit is in the mountainous area southwest of Punta Púlpito and southeast of the Santa Isabel deposit. It is on a high bench on the south side of Arroyo de San Juanico, 2 kilometers south of Rancho San Juanico. The nearest road is about 14 kilometers by trail to the southwest, at Rancho Bombardo on the road between Mulegé and Loreto. No exploratory work has been done at the deposit.

Manganese oxides occur in a nearly flat-lying, fossiliferous, gray sandy limestone, which overlies a reddish conglomeratic sandstone. The fossils are principally pectens and medium-sized oysters, but their age was not determined. The manganese oxides occur in scattered veinlets, pockets, and irregular patches, and are of the hard botryoidal psilomelane type, accompanied by veinlets of calcite. The veinlets of manganese oxides range from 1 millimeter to 10 or 15 centimeters in width and are generally not traceable for more than a few meters along their length. They are thinly scattered over an area about 100 meters long and 3 to 6 meters wide.

The San Juanico deposit is not regarded as having commercial value because of the thinness and small extent of the veinlets and the relative inaccessibility of the locality.

CHIHUAHUA

BORREGOS AREA (1)

A group of fissure deposits consisting of black calcite in rhyolite is found in the Borregos area, 15 kilometers by airline southeast of the railroad station of Guzmán in northern Chihuahua. The area is 31 kilometers from Guzmán, in mountainous country having some 600 meters of relief.

In March 1943 the principal property, the Consolidada, was being operated by the Tennessee Corp.; at that time approximately 75 men were working on the property. The ore from the mine had to be sorted by hand and concentrated in jigs, in the ratio of about one part of concentrate to one part of waste, to bring the grade up to 40 percent of manganese. An unknown amount of ore was said to have been produced from the Consolidada deposit during World War I, and 6,000 tons of ore was said to have been shipped during 1941–42. Early in 1943 some 300 tons of ore containing more than 40 percent of manganese were being shipped each month to the mills of the Tennessee Corp. in Tennessee.

The Santa María deposit (Chihuahua 1g), 2 kilometers north of the Consolidada property, was the only other deposit being worked at the time the region was visited. It is smaller than the Consolidada deposit and, up to March 1943, had produced only 350 tons of ore. The Borregos area contains some of the best fissure deposits in northern Mexico; thus, it offers promise of a continued production.

Consolidada deposit (1a).—The Consolidada deposit is one of the better manganese deposits in the State of Chihuahua. It consists of two veins that intersect at an angle of 45°. The main vein trends northward and dips nearly vertically. It has been worked by means of adits and shafts for at least 300 meters along its length and presumably extends for some distance beyond these workings. It ranges in width from 1 to 5 meters and averages about 2.5 meters. The second intersecting vein trends northwestward. It is at least 100 meters long and from 1 to 2.5 meters wide, averaging about 2 meters.

The ore in the veins consists of typical black calcite, most of which has been dissolved by rain waters near the surface. The north-trending vein is estimated to average from 25 to 30 percent in manganese and the northwestward-trending vein from 30 to 35 percent.

Mr. Love, the manager of the Consolidada mine, said that other manganese veins have been found on the property, but that they had not been mined because of their small size.

Santa María deposit (1g).—The Santa María deposit may perhaps be along the same fracture system as the Consolidada, although its veins trend eastward instead of northward. Three veins are present, all of them on the flank of the mountain, about 200 meters above the road, from which they are reached by trail. Two lying at the east end of the property, some 35 meters apart, are about 50 meters long and half a meter to 1 meter wide, averaging 80 centimeters; they had been mined to a depth of about 10 meters along a part of their course. Another vein of similar dimensions, which lies 300 meters to the west of the other two veins and more or less in a line projected from them, was being explored when the property was visited in March 1943. At that time the deposit was being operated by about 20 men. The production was said to have been 350 tons of ore, which had been sold to brokers in El Paso.

REFUGIO DEPOSIT (8)

The Refugio deposit is 140 kilometers south of El Paso, Tex., and 40 kilometers east of the rail station of Ahumada. It was said to have been owned in 1943 by Jesús T. Porras Villegas and leased to Louis B. Goldbaum. It is of the fissure type in volcanic rocks, but no direct information was available as to the exact nature of the ore. The ore was reportedly so lean that it could not be sorted effectively to bring the grade up to 40 percent of manganese, and work was consequently abandoned. One hundred and fifty tons was said to have been stockpiled at the Ahumada rail station in June 1943, and another 200 tons at the mine. None was known to have been sold or shipped.

CASAS GRANDES AREA (9)

The Casas Grandes area is one of the most promising in Chihuahua. The principal deposit is in the Don Cuco claim (9a). Several mineralized fissures in nearly horizontal layers of rhyolitic rocks are found along a northward-trending zone 3 kilometers long and 1 kilometer wide. The ore in these fissures consists of partly leached black calcite. Up to March 1943 the area had produced 500 tons of ore containing from 41 to 43 percent of manganese, which had been shipped to brokers in El Paso.

Don Cuco deposit (*9a*).—The Don Cuco deposit lies 6 kilometers southwest of Nuevo Casas Grandes and about 4 kilometers west of the rail station of Huerta. In 1943 it was owned and operated by Julián Aguilar of Nuevo Casas Grandes, and in March of that year some 50 men were working on the property.

The deposit consists of four vertical veins in rhyolite that dips 10° to 20° E. The principal vein strikes east; it is 150 meters long and from 30 centimeters to 10 meters wide. Its greatest width is at its intersection with another fissure that trends N. 75° W. and is 60 meters long; most of the ore mined came from this intersection. Two other veins, 30 meters apart, are 40 meters north of the main vein. These trend northward and are from 30 to 60 centimeters wide and 50 meters long. Two adits and half a dozen cuts had been driven into the main ore body, and numerous prospect pits had been dug on the other veins.

The ore consists of typical black calcite, which shows a banding parallel to the trend of the veins. The calcite has been leached out near the surface, but locally the outcrops are composed of nearly fresh black calcite. The average grade of the ore in the main vein is about 30 percent manganese; thus, 2 or 3 tons of mined ore has to be sorted to produce 1 ton of marketable ore. The grade of ore in the other veins is in general lower, about 25 percent manganese.

The production to March 1943 amounted to 500 tons, and a stock pile of partly sorted ore of equal tonnage was stored at the mine. The Don Cuco deposit is one of the best black-calcite deposits in Mexico.

Orizabeña deposit (9c).—The Orizabeña deposit is 3 kilometers south of the Don Cuco. In 1943 it was owned by Julián Hernández of Casas Grandes, and the ore was sold to Julián Aguilar. When the deposit was visited in March 1943, three men were working there.

The property contains two veins, one trending eastward, the other northward, and both dipping vertically. The main, eastward-trending vein is 30 meters long, although 30 meters beyond its western end the ore reappears for some 15 meters; the northward-trending vein is less than 30 meters long. Both veins are from 30 to 60 centimeters wide. The average grade of the ore is about 20 percent of manganese, although in places pockets of high-grade oxide ore have been found. These have supplied most of the ore that has been shipped.

Up to March 1943 the production from the deposit amounted to only 50 tons of 41 percent manganese ore. The deposit is small and has little promise of yielding a large amount of ore.

Azatlán veins (9d).—The Azatlán deposit consists of two veins; in 1943 these also were owned by Julián Hernández. When visited in March of that year the deposit was being prospected by three men, who had opened two cuts 15 meters in length. The main vein trends N. 30° E. and dips 70° W.; it is 150 meters long and 30 centimeters wide. The other vein lies some 30 meters to the southwest and trends more to the east. Both veins are 30 centimeters thick. The manganese content of the ore is relatively low, the average of the main vein being approximately 25 percent and of the other 15 percent. No ore had been shipped up to March 1943.

Tapatía deposit (9e).—The Tapatía deposit was owned in 1943 by Julián Hernández, of Casas Grandes; it consists of two veins, which are 300 meters west of the Azatlán deposit (9d). One vein trends N. 40° E. and the other N. 20° W. Both are about 50 meters long and 30 centimeters thick. The average manganese content of the ore is about 15 percent, although a few small kidneys of high-grade oxide ore also have been mined. One such kidney of mammilary ore, 2 by 3 meters in area and 30 centimeters in thickness, was exposed in a cut in March 1943. A few small stringers of ore not more than 15 centimeters thick are found in some other parts of the claims owned by Sr. Hernández.

MAGISTRAL MINE AREA (26)

According to the files of the Foreign Economic Administration (10), a deposit controlled by Jack Ryan, of Chihuahua City, is near Magistral and a few kilometers beyond the old copper property of the American Smelting and Refining Co. Mr Ryan reportedly sank a shaft to a depth of 130 meters in search of gold and silver and found ore containing from 30 to 35 percent of manganese and from 300 to 700 grams of silver per metric ton. No tungsten or cobalt was present in the ore. The ore body was said to form a "manto," or nearly horizontal layer, 3 or 4 meters thick.

ZACATE MINE (27)

The Zacate mine was opened in one of the largest fissure deposits in Mexico. It is 26 kilometers south of the Las Palmos station on the Noroeste Railroad and 40 kilometers southwest of Chihuahua City. In 1943 it was owned by Leo Naudín, of Chihuahua City, but was formerly owned and operated by Enrique Fáber.

The ore is found mainly in a fractured zone in rhyolite. During World War I the ore was apparently taken from the main fissure zone, and is managanese content presumably averaged 30 percent; in 1943 it came from brecciated rhyolite impregnated with stringers of black oxide similar to the mode of occurrence in the Gavilán deposit in Baja California. The whole brecciated zone is estimated to contain only 10 or 15 percent of manganese. The ore lends itself, however, to concentration in hand jigs, although the operators have had difficulty in concentrating it to 40 percent of manganese.

The principal vein is 100 meters long and from 3 to 15 meters wide. Along it several open-cuts as much as 15 meters in width have been driven. The mineralized zone varies in grade almost in direct proportion to the extent of brecciation of the pink rhyolitic host rock.

Production is reported to have been 5,000 tons during World War I and 4,000 tons within the past few years, all of which was delivered to the steel company in Monterrey. Some 100,000 tons of ore containing 10 or 15 percent of manganese is estimated to be present, of which probably 10,000 tons averages 30 percent.

For a distance of 1.5 kilometers to the south of the Zacate mine, several veins as much as 50 meters in length and from 30 to 60 centimeters in width have been explored to depths of 10 meters. In 1943 they were nearly mined out, although to the southwest, near the top of the hill, there were several fissure zones that had not been explored. The zones are likewise only 30 to 60 centimeters in width.

A note in the files of D. F. Hewett (15) mentions that a mine in this vicinity was operated in 1918 by Leonard and Wercester, who produced a carload a week of ore containing from 34 to 40 percent of manganese.

Chino deposits (*27a*).—The Chino property, three kilometers south of the Zacate mine, belonged to Leo Naudín in 1943. The deposits were operated between 1915 and 1940 by Sr. Fáber, but no work has been done since then. The property contains six parallel veins that strike north and dip 40° to 70° E. The distance across this belt of veins is 100 meters. The veins range in length from 3 to 300 meters and in width from 30 to 120 centimeters. Twenty or more cuts are present, many of which are filled with waste rock. The ore consists of black calcite which contains from 25 to 30 percent of manganese and which must be sorted carefully to bring the grade up to 40 percent.

Production from the deposits is reported as 3,000 tons, much of which is said to have been shipped to the steel plant in Monterrey. The veins have been nearly depleted of easily minable ore, and the best chance for obtaining additional ore is to drift along some of the better veins, preferably toward the north, for a large canyon is south of the main workings. It may be necessary to drive 200 meters before encountering good ore, but as the old workings are so deep that hand hoisting is not particularly attractive, it seems best to drive an adit and then a crosscut. The ore may not persist at depth, however, and many of the veins may actually be mined out. The deposit may contain reserves of 15,000 tons of ore containing from 25 to 30 percent of manganese, but this is questionable; the depth to which the veins extend could not be determined because of fill material in the workings.

ORGANOS DEPOSITS (29)

The Organos deposits are among the more promising of those in Chihuahua. The deposits are in the Sierra de Los Organos, 50 kilometers northeast of Saucillo on the Mexican National Railroad, and 100 kilometers southeast of Chihuahua City. They were said to be owned in 1943 by Manuel Gómez of Las Delicias and Saverio Dávila of Saucillo. At that time they were being operated by the Cía. Explotadora de Minerales. They are on a ridge 3 kilometers by trail from the end of a rather poor road from Saucillo. One disadvantage of this road is that the Conchos River must be forded a short distance east of Saucillo, preventing the transportation of ore during the summer rainy season when the river is high.

Two veins in rhyolite are present in the area. The main vein is 250 meters long, although it is continuous for only 150 meters; it ranges from 60 to 240 centimeters in width, averaging 120 centimeters. The northern half of this vein seems to be fairly uniformly mineralized. In April 1943, four cuts had been opened in it to a maximum depth of 6 meters. Near its south end the vein branches, and there the ore is relatively much richer. The east branch is rather poorly mineralized for 100 meters south of the junction; then it increases in grade for a distance of 30 meters, beyond which it fades out abruptly. This branch has not been mined. The west branch is poorly mineralized to a point 50 meters south of the fork; 15 meters beyond this point it widens into a body with a maximum width of 120

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centimeters, and a linear extent of 15 meters. One cut has been made on this part of the west branch.

The ore consists of black calcite, whose manganese content generally ranges from 25 to 35 percent. The ore has to be sorted by hand to bring the grade up to 40 percent of manganese. To 1943 some 300 tons of ore containing from 40 to 43 percent of manganese had been shipped.

Socorro deposit (29c).—The Socorro deposit is located 10 kilometers west of the Organos deposits, across a broad valley in a low range of hills called Sierra de la Tinaja. It was owned in 1943 by Saverio Dávila and leased to the Cía. Explotadora de Minerales. This property contains two vein systems: one is the westerly continuation of the northeast vein in the Escondida claim (29d) and contains little ore; the other trends southeast up the mountain and is said to consist of two veins, one of which attains a width of 120 centimeters and is more than 150 meters long. No ore had been produced from this property before April 1943. Reserves are estimated to be 500 tons of ore containing 25 percent of manganese.

Escondida deposit (29d).—The Escondida deposit adjoins the Socorro on the east. It consists of two main vein systems. One of these runs N. 50°–80° E. for at least 150 meters, but it is mineralized only at intervals, in lenses 30 meters or less in length and about 1 meter in maximum thickness. The best ore is at the west end of this system, where several exploratory cuts were made in 1943. The second vein system consists of two fissures, about 500 meters southeast of the east end of the first system. The main vein in this system strikes N. 30° W., and has a maximum width of 6 meters. Its average width is 1.5 meters, and the main ore body is 40 meters long. About 100 meters south of this ore body is another vein, which strikes N. 10° W. and dips 80° E. Its width is 1 meter and its length is 15 meters. The ore in the veins of the east system contains 20 or 25 percent of manganese. Little ore was produced from this deposit before April 1943.

TALAMANTES MANGANESE DISTRICT (31) [4]

The Talamantes district [5] has been the second largest manganese-producing district in Mexico, surpassed only by the Lucifer mine in Baja California. It is in southern Chihuahua, 30 kilometers along an unimproved road east of Parral, which is on the Jiménez-Santa Bárbara branch line of the Mexican National Railroad. The manganese mines are on Mesa de Talamantes, which is formed of resistant rhyolite flows and rises 100 to 150 meters above the general level of the surrounding alluvium-covered plains. The mesa is crossed near

[4] Description of the Talamantes manganese district has been written by Ivan F. Wilson and Victor S. Rocha.

[5] For a more complete description, see Wilson, I. F., and Rocha, V. S., Manganese deposits of the Talamantes district near Parral, Chihuahua, Mexico: U. S. Geol. Survey Bull 954-E, 1948.

its north end by the Río de Santa Bárbara, which provides an abundant supply of water.

The manganese district is covered by 25 claims owned by four groups of persons. The largest group of claims, including the largest producing mine, the San Antonio, is owned by the brothers J. Antonio Fernández and Horacio Fernández. Some claims in the northern part of the district are owned by César Díaz. Two others are owned by Saturnino Chávez, and another by Francisco Aguirre.

Production from the deposits began during World War I; it was intermittent until 1930 and has been more or less continuous since then. Until World War II most of the ore produced was shipped to the steel mill at Monterrey, Nuevo León, operated by the Cía. Fundidora de Fierro y Acero de Monterrey, S. A., and more recently it has been shipped to the Metals Reserve Co. at El Paso, Tex. Production figures are incomplete and inaccurate, but according to the operators the production through April 1944 from the Fernández brothers' properties was about 36,000 tons; that from the other properties may have produced about 15,000 tons, so the total production from the district through 1944 is in the neighborhood of 50,000 tons. Ore produced in 1944 contained from 40 to 44 percent of manganese, but some of that previously shipped probably was of poorer grade. The rate of production from the San Antonio mine early in 1944 was reported as 350 tons per month. At that time about 30 men were employed there, but the other mines in the district were being worked by "gambusinos."

The Mesa de Talamantes consists of gently dipping flows of rhyolite and layers of rhyolite tuff, volcanic breccia, agglomerate, and tuffaceous sandstone, all of Tertiary age, resting unconformably on folded limestones which are probably Cretaceous. The rocks are cut by a series of northward-trending normal faults, the largest of which divide the mesa into a series of blocks, that are, from west to east, (1) a horst, (2) a minor graben, and (3) an eastward-tilted block. The faults dip 60°–80° E. or W., and most of them strike a few degrees west of north, although some strike slightly east of north. Most of the faults have smooth slickensided footwalls, and a few have smooth hanging walls. The striations on the walls show an important horizontal component of displacement.

The manganese deposits occur in brecciated zones along the faults. Some of the ore is in narrow well-defined veins along fissures, but most of it is in veinlets and irregular masses that incrust rhyolite fragments in the fault breccia. Manganese oxides have impregnated and replaced the matrix of the breccia, but the rhyolite fragments themselves show very little evidence of replacement.

Some of the numerous veins and brecciated zones that have been explored and mined in the district may be traced for several hundred meters. The most important vein systems are the San Antonio, Libertador, Vida Nueva, Reina (and Amplificación), and Amalia. The San Antonio vein system, consisting of at least three veins, has been explored for a length of 550 meters at the 23-meter level, where it has an average thickness of about 2 meters. The Libertador vein has been explored for a length of 450 meters. The Reina contains a manganiferous brecciated zone as much as 8 meters thick, but most of the other deposits have a thickness of less than 2 meters. Exploration has not been sufficient to establish the vertical extent of the deposits. The deepest shaft in the San Antonio mine reached 42 meters, and at the Vida Nueva mine 40 meters. The veins in the district have been mined by means of open-cuts, shafts, drifts, and overhead stopes. The San Antonio mine has five shafts and an extensive level at 23 meters, above which ore has been stoped out to varying height.

X-ray studies by J. M. Axelrod and chemical studies by Michael Fleischer show that the manganese minerals are psilomelane, which is massive, sooty, and black; cryptomelane (much K, some Ba), which occurs in crystals; hollandite-cryptomelane (much Ba, little K), which occurs in botryoidal forms; and a mineral identified thus far only by X-ray studies, which may be imperfectly crystallized psilomelane. Coronadite (much PB) may be found in the Amalia mine. The associated minerals include calcite, chalcedony, barite, quartz (including amethyst), gypsum, and hematite. Thick barite veins containing minor quantities of manganese oxides also are found in the district. Tungsten occurs in the ore to the extent of 0.4 to 2.9 percent of tungstic oxide, the average being 1.0 percent, and chemical tests show that much of it is contained within the mineral psilomelane.

The average grade of the ore as it is found in the deposits varies from 20 to 30 percent of manganese. In most of the deposits nearly half the ore is composed of rhyolite fragments, which are sorted out partly by hand and partly in hand jigs. The methods of separation used result in considerable loss; as a result, the dumps in the district contain from 18 to 25 percent of manganese. Many of these were being reworked by "gambusinos."

In the district the reserves of inferred ore containing from 20 to 30 percent of manganese are estimated as 100,000 or 125,000 tons. These figures are approximate, however, because of lack of data concerning the possible depth of the deposits. Besides, about 25,000 tons of material containing from 18 to 25 percent of manganese remains in the dumps, and this might be beneficiated if a mill were constructed. The amount of shipping ore containing from 40 to 44 percent of manganese would be approximately half the amounts given above.

MATAMOROS DEPOSITS (32)

The Matamoros deposits are 20 kilometers south of Parral and 3 kilometers south of Villa Matamoros, or Las Cuevas as it was formerly named and is still called by the inhabitants. Some 20 or more claims are said to have been denounced along a northwestward-trending zone, of which six or more were controlled in 1943 by Manuel Duarte, Miguel Mendez T., and Daniel Morales, who live in Villa Matamoros and vicinity. The deposits lie on a flat plain, beside a good road, and are only 8 or 10 kilometers from the railroad to Rosario. When visited in April 1943, work had been abandoned because of the difficulty in obtaining enough ore that could be sorted to 40 percent of manganese.

On the properties controlled by Manuel Duarte and others, six parallel veins which trend N. 30° W. and dip 80° W. are found within a horizontal distance of 200 meters. These veins range up to 30 meters in length and from 8 to 60 centimeters in width, averaging 30 centimeters. The vein system is said to extend 2 or 3 kilometers beyond these deposits in either direction, but little exploration has been done on the adjacent properties.

The ore is found in fissures in rhyolite, principally in chimneys as much as 30 meters high, but with a cross section of 60 centimeters by less than 5 meters. It consists of partly leached black calcite and is irregular and pockety in its distribution. The manganese content is variable but generally less than 25 percent, although in a few places it is as high as 40 percent. The deposits were worked late in 1942, but were abandoned in 1943. Some six cars (250 tons) of ore were reported to have been shipped to the steel plant in Monterrey. A large quantity of ore is not likely to be found in these deposits in the future.

Nuevo Vesuvio deposit (32g).—The Nuevo Vesuvio is an antimony and manganese deposit 27 kilometers southeast of Parral, in the region of the Matamoros deposits. The mine was visited in April 1943 by D. E. White (38) of the Geological Survey, who reported that it was owned by Román S. Concha of Parral.

The country rocks consist of siliceous and calcareous shales intruded by diorite and related porphyries. The presence of these basement rocks suggests that the ore deposit is at some distance from the Matamoros deposits, which are found in rhyolite. Six veins are present on the property. These trend N. 35° W. and dip 70° W., and they range in length up to 50 meters. The two northern veins are richer in manganese than the southern, and near the surface the manganese oxides are mixed with antimony oxides. The more eastern of the northern veins contains more manganese, but the ore is difficult to sort to more than 30 percent of manganese. The mine had produced 100 tons of ore containing from 30 to 35 percent of antimony, but no manganese had been produced. Reserves of manganese ore were estimated by White to amount to less than 1,000 tons containing 35 percent of manganese.

COAHUILA

LUCERO DEPOSIT (2)

The Lucero deposit was controlled in 1943 by Abraham Jiménez Cárdenas and Esteban Ibarra García of Múzquiz. It was leased to Messrs. Leighton and Hull, who worked the property during 1942. The deposit is reached by road from La Esperanza on the railroad, 13 kilometers distant. The owners built the last 3 kilometers of this road up a canyon, and from the road's end constructed a good trail 2 kilometers long to the deposits, which are 600 meters above the floor of the canyon. Leighton and Hull attempted to make ferromanganese from the ore by means of coke, but without success, and when the property was visited in April 1943 they had ceased their operations and the deposit was idle. The ore was found to be too low in grade to sort to 40 percent; none was purchased by the Metals Reserve Co., but one car of 40 tons of ore was ultimately sold to the Monterrey steel plant. In 1943, about 5 tons of 30 percent ore lay piled beside the workings. The property has been explored by three cuts each 2 or 3 meters in length.

The host rock looks much like the limestone of the Glen Rose formation (Lower Cretaceous) of Texas. Its beds strike northwest and dip 5° to 10° NE. The ore body appears to be a vertical chimney, whose maximum dimensions are 30 meters in height and 1 meter in width. The ore is a replacement of limestone and consists of black calcite and a mineral that looks much like braunite. The ratio of calcite to manganese ore is 4:1. Coarsely crystalized calcite crystals 8 centimeters in diameter overlie the manganese.

BALUARTE DEPOSIT

The Baluarte deposit is on the south side of the prominent peak called El Baluarte, 13 kilometers northeast of Las Hermanas in the central part of the State of Coahuila. It is about 300 meters above the plain and is reached by trail. In 1943 it was owned by Sr. Garza Castro of Las Hermanas.

The country rock is massive limestone, which dips 20° N. and strikes east; the ore body is a replacement of this limestone by manganese oxides in a zone 10 meters long and 1 meter wide. The manganese content of the mineralized rock is less than 5 percent. The ore is said to contain about 2 percent of iron. One small cut has been opened in the deposit, but the ore is of low grade and none of it has been shipped. The small size and low manganese content make this deposit of little value.

CANDELA DEPOSITS (6)

In Cerro Colorado, 26 kilometers by airline west of the town of Candela and 12 kilometers northeast of the Panuco mine, a series of manganese deposits has been formed by the replacement of limestone adjacent to a granitic plug. Cerro Colorado rises 250 meters above a broad valley between two strike ridges that trend northwest and form a prominent butte or hill visible for many kilometers. The deposit is 65 kilometers by road from the railroad station on the Piedras Negras line, and 40 kilometers from the Candela rail station on the line from Monterrey to Laredo. More than a dozen prospects are distributed around the periphery of the granitic stock, which is about 1.5 kilometers in diameter. The prospects on the east are controlled by Remigio Martínez, Francisco Farías Zertuche, and C. A. Kelly of Rosita; those on the west by Leopoldo Villareal, Jr., of Saltillo.

The ore in the Milagro deposit, on the east side of the stock, is found along the contact between the limestone and a nearly horizontal sill of fine-grained quartz granophyre. This granophyre seems to be an offshoot from the granitic stock and has intruded the limestone almost parallel to the bedding, which strikes northeast and dips 10° NW. The contact dips perhaps 10° more steeply to the west than the limestone, although it cuts across the beds irregularly. The mineralized zone might, in fact, be considered as lying at the base of a laccolithic sill extending from the granitic stock to the west. This zone is about 15 meters thick and contains coarsely crystallized calcite, barite, fluorspar, and drusy crystalline masses of manganese oxides. According to W. F. Foshag, recent explorations have shown that down the dip into the heart of the hill, the manganese oxides give way in part to alabandite. The manganese ore is in most places found near the base of the mineralized zone, although in some places two zones 1 meter apart are present; in one place the whole mineralized zone consists of managanese oxides. The manganese ore can be considered, however, as lying in a zone from 15 to 60 centimeters thick.

The deposit has been explored for 150 meters along the strike and 100 meters down the dip by a series of drifts and crosscuts. Near the lower part of the exploratory workings down the dip, galena begins to appear. In the deepest part of the excavations, when the deposit was visited in April 1943, the content of galena was at least 20 percent of the total rock. The limestone in the lead zone is less coarsely recrystallized than where the manganese oxides are present. The ore mined contained about 2 percent each of lead and zinc, so it was not acceptable to the Metals Reserve Co. Two analyses of manganese ore from the Milagro deposit are given in table 9. One of the samples was taken by Mr. Skelly and the other by P. D. Trask, from a stock pile of 20 tons of selected ore lying beside the main opening of the Milagro deposit.

TABLE 9.—*Partial chemical analyses of two samples of Milagro (Coahuila 6b) ore*

[Analyzed by J. F. Fyfe]

Sampler	Mn	Fe	P	Pb	Cu	Zn	Al_2O_3	SiO_2	Fines
Skelly	46.5	0.82	0.05	1.86	0.06	2.13	0.03	8.9	
Trask	50.4	T	.04	0.0	.08	1.8	.05	5.3	1.8

The Milagro mine is said to have produced 2,000 tons of ore many years ago. Who mined this ore and where it was shipped are not known. Before 1943, some 300 tons of ore were sold to the Monterrey steel plant, but owing to the low price paid for this type of ore, the operators were not able to make a profit. In April 1943, the deposit was being explored by a force of 10 miners, in the hope of blocking out more ore, so that if a market were found the quantity of ore that could be delivered would be known. About 2,000 tons of material are estimated to lie in the dumps.

The reserves of manganese ore in the group of deposits around Cerro Colorado are estimated to exceed 15,000 tons, containing 40 percent of manganese and 2 percent each of lead and zinc.

Around the border of the stock, half a dozen deposits have been explored by means of shallow prospect pits opened up by Martinez and others, and by Sr. Villareal and associates, but none has been explored for more than 5 meters. These show the same relationship between the granite and the intruded limestone as in the Milagro deposit. Two of these deposits lie less than 100 meters northwest of the main Milagro workings, and three others are found farther to the northwest, at intervals as great as 600 meters from these workings. Similar conditions are found in the Villareal workings on the west side of the stock.

In the central part of the granite stock, a vertical copper-bearing vein was found and worked many years ago, but it is now abandoned.

EUREKA DEPOSITS (7)

The Eureka deposits are located 27 kilometers north of Hipolito on the railroad from Torreón to Monterrey. They were controlled in 1943 by General Gabriel R. Cervera; they were operated in 1942 by Leopoldo Villareal, Jr., and in the spring of 1943 by others. The deposit is found in limestone and is presumably a chimneylike replacement, as are several other deposits in this general region. According to Señor Villareal (36), of Satillo, Nuevo León, the ore body was 3 meters wide at the surface and diminished to a width of 8 centimeters at a depth of 6 meters. A sample of ore examined by the writers looked much like braunite. Some 250 tons of ore were sold to the Monterrey steel plant. Señor Villareal said that the deposit was worked out and that he doubted if much ore was still to be found.

DURANGO

DINAMITA DEPOSITS (2)

The Dinamita deposits are about 15 kilometers southwest of Dinamita, in the northeastern part of the State of Durango, and 30 kilometers northwest of Torreón, Coahuila. They consist of the replacement of massive limestone by black calcite around the periphery of a granitic stock from 3 to 5 kilometers in diameter. The main deposits are the Sarnosa (2b) and the Luz (2g), which is 2 kilometers to the south of the Sarnosa. Half a dozen others, among which are the Nena (2e), Santiana (2c), and Zurita (2b), are known in this general vicinity. Another group of deposits, which includes the Negra (2m) and Providencia (2n), is found on the opposite side of the mountains, on the west side of the granitic stock. This group had not developed into large deposits when the area was visited in 1943, and difficulty was found in sorting the ore to 40 percent of manganese. The Sarnosa, Santiana, and Negra deposits are within a hundred meters of the outcrop of the granitic stock, which protrudes almost vertically into the limestone, but others, such as the Luz and Nena, are as much as 2 kilometers from the granite.

All the deposits seem to be associated with breccia, which was formed in part when the granite was intruded and in part along vertical faults of considerable displacement. The ore is in pockets distributed irregularly throughout this breccia. The deposits were probably of hydrothermal origin when first formed, but the present ore bodies are clearly secondary, for their calcite matrix has been leached out, and the manganese oxides are in powdery form. This fine powder detracts from the value of the ore. Except for the Sarnosa deposit, whose ore contains from 40 to 45 percent of manganese, the ore from most of the others generally averages from 35 to 38 percent.

Production from the area to June 1943 was about 12,000 tons of ore, of which some 10,000 tons came from the Sarnosa deposit and 1,500 tons from the Luz deposit. Reserves in the region are estimated to amount to about 25,000 tons, of which 10,000 tons each are in the Sarnosa and Luz deposits, and 5,000 tons are in the other deposits. The average grade of this ore is estimated to be between 35 and 40 percent of manganese.

Sarnosa deposit (2b).—The Sarnosa deposit is 2 kilometers by trail from the road and 300 meters above the road. It was owned and operated in 1943 by Arturo Villar of Torreón, Coahuila. About 100 men were working on the property when the area was visited in the spring of that year. The deposit consists of a replacement of limestone by black calcite, more or less parallel to a large fault along the edge of a massive stock of medium-grained granite or quartz monzonite This black calcite has been partly leached out; leaving irregular masses of powdery, black manganese oxides that lie parallel to the sides of blocks of limestone breccia.. The primary black calcite is clearly of hydrothermal origin, but the present manganese oxide ore bodies are the result of secondary oxidation and leaching.

The outcrop of the deposit was an area about 1 meter square on the face of a nearly vertical cliff. When explored this area opened into a leached zone 60 meters long and 5 meters thick. One cavity in this zone was 15 meters in diameter and was filled with manganese oxides; another was 6 meters in diameter. In 1943, the operators were following small leads in the hope of finding other such cavities filled with manganese oxides. A typical sample of run-of-mine ore (sample 116, table 5) taken in April 1943 contained 44.1 percent Mn, 1.0 percent Fe, 1.8 percent SiO_2, 1.05 percent WO_3; 0.06 percent Al_2O_3; 0.04 percent Cu; 0.02 percent Pb; and traces of Zn and P. It contained 27.6 percent of fines.

Before April 1943 some 10,000 tons of ore had been shipped to the Monterrey steel plant, but because of the high proportion of fines, none had been accepted by the Metals Reserve Company. The reserves are difficult to estimate, but they may perhaps amount to as much as 10,000 tons of ore containing approximately 45 percent of manganese.

Nena deposit (2e).—The Nena deposit was owned in June 1943 by General Zurita and was being operated by Theodore Symons. It is about 2 kilometers south of the Sarnosa mine (2b) and 3 kilometers farther from the rail station at Dinamita. The route to the railroad could easily be shortened by 5 kilometers if a new road 1.5 kilometers along were constructed, as the way lies across flat country sparsely covered by brush. The deposit is in the east face of a sharp scarp, about 220 meters above the road, and is reached by a good trail about 1 kilometer long. About 20 men were working on the property in 1943. The ore is found along a fissure in limestone in a zone that is 60 meters long and 15 meters deep and that average 2.5 meters in width. The main part of the ore body lies in a cave 15 meters long, 15 meters deep, and as much as 6 meters wide. Ore is found along the walls of this cave and extending along the fissure zone beyond it. A tunnel was driven about 8 meters below the exposed ore to simplify mining. The full extent of the body was not known when the deposit was visited in 1943. The ore consists of a mixture of black calcite and powdery manganese oxides, similar to the ore in the Sarnosa (2b) and Luz (2g) deposits. It averages 35 percent in manganese and was being sorted to 38 or 40 percent.

Before June 1943, about 100 tons of ore estimated to average 38 percent in manganese and 4 percent in silica had been mined. Reserves indicated by the workings existing at that time were estimated to amount to 2,000 tons containing 38 percent of manganese.

Luz deposit (2g).—The Luz deposit in 1943 was owned by the García brothers and was being operated by Ernesto Madero and associates. It is 25 meters above the base of a vertical cliff, 1 kilometer west of the Nena deposit (2e). It is reached by a trail 3 kilometers long, which leads up the canyon from the end of the road; from there ascent is by means of a wire rope, 10 meters up the cliff. About 50 people were working in the mine in June 1943. The ore was being carried on burros, which made five trips a day, to the road at the end of the trail where it could be picked up by trucks.

The deposit is found in horizontal beds of massive limestone and is exposed in a vertical wall 150 meters high. This wall was formed by erosion along the plane of a joint or, more probably, a fault. As originally exposed, the outcrop of the deposit formed an area 10 meters long by 1.5 meters high. Three open-cuts had been made in this outcrop. The largest and westernmost cut follows a narrow zone that, inside the mountain, widens into an ore body 50 meters long, 10 meters wide, and 5 meters in average thickness. When the property was visited in June 1943 the limits of this body had not been determined. Two other prospect pits, 20 meters and 30 meters, respectively, southeast of the main opening and at approximately the same level, encountered relatively little ore and were not being worked.

The ore from the Luz deposit contains about 38 percent of manganese and less than 5 percent of silica. About half of it is black calcite, and the rest is a soft powder similar to the ore in the Sarnosa deposit (2b). The ore that was shipped was mixed with high-silica ore from the Abundancia or Colorado deposit (Zacatecas 7). Before June 1943, production was said to have amounted to 1,500 tons of ore containing 38 percent of manganese. Reserves are estimated to amount to some 10,000 tons of ore of the same grade.

Negra deposit (2m).—On the west side of the granitic intrusion around which the Dinamita deposits are situated, several other manganese deposits of the same general type have been found, although up to June 1943 no large ore body had been discovered. When the area was visited in April of that year the largest deposit, the Negra, was being worked by five men and had been explored to a depth of 3 meters and for a length of 6 meters. As difficulty had been encountered in sorting the ore to a grade of 40 percent of manganese, the owners, Señora Julia Pamones de Cueto and Licenciado Lucas Haces Gil of Torreón, were considering stopping the work.

The ore consists of manganese oxides and black calcite, in bodies that replace limestone breccia 100 meters distant from the granite stock. The limestone is recrystallized to a fine-grained marble, whose grain size is about 2 millimeters, and in places it is stained red with iron oxides. Because of the similarity of this deposit to the Sarnosa on the other side of the granite stock, where tungsten had been found, samples of ore from the deposit were examined with an ultraviolet lamp, but no tungsten in the form of scheelite was seen. The average grade of the ore is about 38 percent in manganese. No ore had been sold before June 1943, and no significant reserves had been blocked out.

PICACHO DE LA CANDELA DEPOSITS (3)

The Picacho de La Candela deposits are among the most inaccessible manganese deposits in Mexico and have been visited by very few people. They lie 30 kilometers by air line east of Tepehuanes, which is at the end of the branch railroad extending northwestward from Durango City. The nearest rail stations are Presidio and Sandía, each about 25 kilometers southeast of Tepehuanes, and from these the deposits are 35 kilometers distant by steep trail. The deposits may be reached by road from Presidio to the Brock lumber camp, 40 kilometers distant, and from there by trail for 17 kilometers. They may be reached also by trail 5 kilometers up the valley from Matamoros and 30 kilometers by country road from the Palmito dam, which is, in turn, 150 kilometers by all-weather road from Mapimí on the railroad. In the spring of 1943 the ownership of the deposits had not been clearly established.

Three types of deposits are present in the region: (1) a replacement of tuff by silica, jasper, and manganese oxides, as in the Guadalupe deposit (3e); (2) manganese oxides in a breccia zone along a fissure, as in the Cía. Minera Central deposit (3c), which lies 2 kilometers east of the Guadalupe; and (3) coatings of secondary manganese oxides on the surface of a calcified tuff, as in the Esperanza deposit (3b), which is 1 kilometer west of the Guadalupe. The best of these is the Guadalupe deposit, but as its ore contains around 2 percent of zinc and is difficult to sort to 40 percent of manganese the ore cannot readily be marketed. The average ore in the Cía. Minera Central deposit contains about 15 percent of manganese; it cannot be sorted effectively for marketing. These two deposits have been prospected by means of several pits and adits.

Practically all the ore produced up to June 1943 came from the Guadalupe deposit. Not more than an estimated 25,000 tons of 30-percent ore remains in this deposit; probably not more than 10,000 tons remains in the other deposits in the area.

Esperanza deposit (3b).—The Esperanza deposit lies 1 kilometer west of the Progreso claim (3a) and has been prospected by only one adit, which is 8 meters long. The deposit is said to have been owned in 1943 by Angel Buñis and operated by the Cía. Minera Central. The ore consists mainly of drusy coatings of high-grade, mammillary manganese oxides, on a fracture plane in calcified tuff. This bed of tuff extends east and west for a distance of 600 meters and is 1 meter thick. Manganese ore is present in three places along the outcrop of the tuff, but the workings are only in the exposure near the west end, where ore is found at intervals for a distance of 50 meters. The adit driven into the tuff in this place encountered oxide ore only at its entrance. The grade of the ore found in the drusy coatings exceeded 45 percent of manganese. At the west end of the bed of tuff, a shaft was sunk several years ago in search of gold, but only galena was found. No ore had been produced from the deposit in 1943, and the reserves are estimated to be small.

Cía. Minera Central deposit (3c).—The Cía. Minera Central deposit lies in the second ridge northeast of the Guadalupe deposit (3e), and about 2 kilometers east and a little north of the Progreso (3a) deposit. It consists of several ore bodies at intervals along a fissure zone trending due north to N. 40° W. and dipping nearly vertically, in rhyolitic agglomerate, which in turn dips somewhat gently southward. Several cuts had been made in the more favorable localities in 1943, but little ore containing more than 15 percent of manganese was found. About 25 tons of ore had been produced when the deposit was visited in the spring of 1943, and 5 tons of sorted ore estimated to contain 35 percent of manganese lay in a pile beside one of the cuts. The reserves in the deposit are estimated at 5,000 tons of ore containing about 15 percent of manganese.

Guadalupe deposit (3a).—The Guadalupe deposit contains the best ore body in the Picacho de La Candela region. It is about 300 meters north of Picacho de La Candela (Candlestick Peak), which is a high rhyolitic peak notable for its sharpness. The deposit was controlled and operated in the fall of 1942 and spring of 1943 by Darrell M. Wonn, and when it was visited in March 1943 work had been abandoned because the ore had failed to meet marketing specifications.

The manganese ore occurs in silicified rhyolitic tuffs, which strikes northeast and dip 45° to 65° SE. These tuff beds seem to be broken by faults in this general region, and no continuous ore zone is present. The deposit runs into massive rhyolite on the south, where it is seemingly cut off by a fault, and it lenses out to the north. The silicified zone is 60 meters long and 25 meters wide; it is mineralized irregularly with manganese and iron oxides, locally with red and yellow jasper. Two zones about 15 meters apart, generally 2 or 3 meters thick and parallel to the main trend of the tuffs, have been particularly enriched with manganese oxides. The easternmost one has been explored by an open-cut, or "patio" as it is called locally, and the other by an adit 10 meters long. Little ore containing as much as 40 percent of manganese was seen in these mineralized zones, and it would be difficult to keep the silica content of the ore below 15 percent.

The deposit is reported to have produced 175 tons of ore containing from 35 to 42 percent of manganese and as much as 2 percent of zinc, but only one car load was accepted by the Metals Reserve Co. It is doubtful if more than 25,000 tons of 30 percent ore remain in the deposit.

GUANAJUATO

VICTORIA MINE (2)

The Victoria mine is in the northern part of the State of Guanajuato, 14 kilometers north of León. It is 20 kilometers from the nearest rail station, from which it is reached over a narrow mountain road. The deposit was first explored during May 1942; when visited in May 1943 it was being worked by about 50 men. It was owned at that time by Sr. Villaseñor Rangel, and was leased to Crédito Minero.

The ore is found in lenses of salty shale that range from 3 to 30 meters in length, 1.5 to 15 meters in width, and 1.5 to 3 meters thickness. These lenses strike northwest and dip 30° to 45° W. Five such lenses, occurring at intervals in a zone 300 meters long, had been explored in 1943, and at that time they were largely mined out. The operators were prospecting actively for more ore down the dip of some of these mined-out lenses, but the chances for success were small, for apparently once having pinched out, the lenses almost never repeat themselves down dip. The ore is cut by quartz veinlets as much as 1 centimeter wide, and as the manganese content averages only about 30 percent, the ore has to be hand-sorted to bring the grade up to 40 percent. The primary manganese minerals are probably silicates, although as all the lenses that had been mined or explored were still within the limits of the zone of oxidation, no primary minerals could be identified with certainty.

Before May 1943 the mine had produced 300 tons of ore containing from 40 to 45 percent of manganese, which had been shipped to the Metals Reserve Co. The dimensions of the known ore bodies are such that a large tonnage of reserves cannot be expected to remain in the deposit.

PROTECTORA DEPOSIT (3)

The Protectora deposit is 14 kilometers east of León, in the mountains 13 kilometers by trail from the Trinidad rail station. It was controlled in 1943 by Justo Pedroza of Silao. The property was worked in the fall and winter of 1942, but was abandoned when visited in May 1943.

The ore occurs in lenticular bodies in slightly metamorphosed rhyolitic porphyry, along a contact between this rock and a granite stock to the west. Three lenses of ore, each about 100 meters apart, are found in a zone that trends N. 70° E. and dips 60° to 70° N. The ore bodies range in length up to 30 meters, in width to 15 meters, and in thickness to 6 meters. The central deposit is the largest and richest, and in it a cut 12 meters in diameter and 6 meters deep exposes an ore body whose dimensions are 6 by 6 by 5 meters. Near the surface the ore consists of manganese oxides impregnated with leached silica, which gives way with depth to fine-grained, purplish-pink rhodonite. Blocks of rhodonite 2 meters in diameter were found in the bottom of the cut. The ore contains a small proportion of tiny greenish grains that might be apatite, which may account for a reportedly high phosphorus content of as much as 4 percent.

The deposit is reported to have produced 200 tons of ore containing from 36 to 40 percent of manganese and as much as 4 percent of phosphorus, which made the ore difficult to market. The two adjacent ore bodies, which consist of low-grade manganese oxides at the surface, are estimated to average only about 20 percent of manganese.

Because the ore passes almost certainly into rhodonite with depth the deposit is not of great value. Reserves are estimated to amount to 3,000 tons of ore containing 35 percent of manganese, of which at least 60 percent is in the mineral rhodonite.

Guanajuato deposit (*3a*).—A deposit mentioned in a letter in the files of D. F. Hewett (15) of the U. S. Geological Survey, was said to be located near León, Guanajuato, and to have been controlled in 1918 by H. C. Baldwin and a Sr. Rosada, who at that time had a contract for 20,000 tons of ore that were to have come from this deposit. The letter states, moreover, that some 500 tons of ore containing 50 percent of manganese and 5 percent of silica were mined from a deposit 3 kilometers from the Protectora (3). Whether these two are the same deposit is not clear, nor were they identified by the writers when the area was visited in 1943. They might represent the Victoria deposit (2), although that is 16 kilometers northwest of the Protectora (3). The ore was reported to consist of psilomelane and rhodochrosite, and to contain 43 percent of manganese and 10 percent of silica. As his deposit could not be identified in the field, its production is not included in table 2 because of a possible duplication of figures. The reserves are thought possibly to amount to several thousand tons.

GUERRERO

BUENAVISTA REGION (4)

Some 15 deposits are known in the Buenavista region, which is 15 kilometers southeast of Taxco and 10 kilometers northeast of the rail station of Buenavista. Most of them were controlled in 1943 by Mario Jiménez Galindo of Buenavista, and were operated largely on a "gambusino" basis. The ore was sold to Comercio General of Mexico City, which in turn sold it in the United States. Some ore was also sold to the Monterrey steel plant, and one carload was shipped to the Electrometallurgical Co. of Alloy, W. Va.

The deposits are found in chimneys of brecciated massive limestone, along fissures located from 5 to 150 meters from the contact between the limestone and a granitic stock from 3 to 5 kilometers in diameter. These fissures are roughly parallel to the contact, and the ore chimneys in them are small. The ore consists of black calcite and secondary manganese oxides, generally found in stringers from 5 to 10 centimeters wide ramifying through the chimneys. In a few places, notably in the María, Carmen, Unión, and Porfirio deposits, pockets of ore have been found that are as much as 3 meters wide. The manganese minerals have only partly replaced the limestone, and the manganese content of the ore bodies varies from 2 to 50 percent of the material mined. The ore shipped to Alloy, W. Va., ran: 43.67 percent Mn, 0.33 percent Fe, 2.51 percent SiO_2, 1.03 percent Al_2O_3, and 0.13 percent P.

Production to June 1943 is estimated to have amounted to 400 tons, most of which came from the Unión (4n) and Carmen (4h) deposits. When the region was visited, about 1 ton of ore a week was being produced. Reserves are estimated to amount to 2,000 tons of 40-percent ore, although this amount will probably not be mined, for the better deposits had already been worked out in 1943. Future production will depend upon the discovery of new deposits in some of the mineralized breccia zones.

India deposits (6g).—The India deposit lies across the canyon south of the Dos Lupes (4d) and Vidal (4f) deposits, about 10 kilometers by trail from the rail station of Amates. It was owned in 1943 by Enrique Ballena of Amates and was controlled by H. W. Fowler and associates. The deposit had been explored by means of two small cuts 3 meters in length. The ore is found in brecciated limestone partly replaced by manganese oxides, along a zone trending N. 60°

W. and dipping 60° SW. This zone extends for a distance of perhaps 150 meters but is mineralized extensively in only one place. There the ratio of manganese oxides to limestone is about 1:1, or 1:2. The ore would have to be sorted carefully to bring the grade up to 40 percent in manganese. No ore had been produced when the deposit was visited in June 1943.

Carmen deposit (*4h*).—The Carmen deposit is 3 kilometers southeast of the India (4g), on the west side of the granite stock and about 8 kilometers by trail from the rail stations at Amates and Pimental. It was owned in 1943 by José Merino and was controlled by Comercio General. The manganese ore occurs in two chimneys about 200 meters apart. The southern chimney, which is 50 meters west of the granite contact, was explored and mined by means of two cuts 35 meters apart, and the northern one by a cut 6 meters in length. The ore in these chimneys forms only about 20 percent of the rock and is difficult to beneficiate by sorting. Production to June 1943 is estimated as 200 tons, most of which was said to have been shipped to the Monterrey steel plant. The deposit seems to be largely mined out and offers little promise of yielding more ore.

Unión deposit (*6n*).—The Unión deposit is 100 meters southeast of the Cabrillo (4m), 60 meters east of the granite contact and about 9 kilometers by trail from the railroad at Buenavista. It was last mined in 1942. The ore is found in finely recrystallized limestone in a zone 20 meters long, 6 meters wide, and 3 meters thick. The proportion of ore to waste rock is low, and the average grade of the ore body is about 30 percent in manganese. Up to the time when mining stopped (1942), some 100 tons of ore had been produced. It was shipped mainly to the Monterrey steel plant. The deposit is apparently almost mined out.

María deposits (*4p*).—The María deposits are 5 kilometers south of the Negra deposit (2o) and are at least 1.5 kilometers from the granite stock. They consist of two deposits; one of these is adjacent to the railroad, and the other is about 300 meters to the north. Both were owned in 1943 by José Merino; they were mined during 1942 but were abandoned in 1943. The northernmost deposit was explored by means of one cut 15 meters long, in which the ratio of manganese ore to limestone is about 1:4. The southern ore body consists of a breccia zone 12 meters long and 6 meters wide, in which the manganese content is about 20 percent. This deposit had not been mined. The production is said to have amounted to some 50 tons of ore, all from the northern deposit. The property may still contain 1,000 tons of 15-percent ore, or perhaps 50 tons of 40-percent ore.

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CONSUELO DEPOSITS (5)

The Consuelo deposits are about 80 kilometers northeast of Acapulco and 7 kilometers to the east of the paved highway from Mexico City to Acapulco, by a trail that starts at a bend in the highway near kilometer 342. The country is brush-covered, and from June to October receives much rain, which makes mining difficult. The deposits were owned by Galvo Ortega in February 1943 when the area was visited, and negotiations were under way with Productos Mineros Mexicanos for their exploitation, which was then being carried on by only a few miners. Mr. Arnold, one of the principals of Productos Mineros Mexicanos, died in April 1943, and work at the deposits flagged until May, when Dr. Volf of the Cía Mercantil Reforma became interested. It is not known, however, whether this company worked the deposits.

The ore is found in chimneys in fissures that cut through massive limestone, in a zone 250 meters long that strikes east and dips 40° N. Four cuts were made along this zone; one of these is 30 meters long and 10 meters deep. About 100 meters northwest of the main cut is a shaft that was said to extend to a depth of 30 meters. The ore consists of residual oxides derived from johannsenite, a manganese-bearing silicate. At one place the primary silicate mineral was found within 50 centimeters of the surface, but in others the oxidized zone extends to a depth of at least 10 meters. In places galena is found with the ore. At the shaft, no ore shows at the surface, and seemingly little good ore was encountered at depth.

Sorted ore was carried by burros to a stock pile along the highway, but none had been sold in 1943. Reserves are estimated to amount to 3,000 tons of 30 percent ore, of which a large part is manganese silicate.

Northeast of the Consuelo deposits, long tongues of limestone apparently grade into agglomerate, and faults with more than 100 meters of displacement seem to be present.

Lucky Nina deposit (5a).—The Lucky Nina deposit is 500 meters west of the Consuelo deposits (5). It was owned in 1943 by Productos Mineros Mexicanos, which had a contract with the Metals Reserve Co. The sorted ore was hauled to a stock pile along the highway, where it was to have been trucked to Naranjo on the railroad, some 160 kilometers distant. Shipping costs from the mine to Laredo then amounted to 59 pesos a ton: 15 pesos from the mine to the highway, 30 pesos from there to Naranjo, and 14 pesos by rail to Laredo. Because of the difficulty in concentrating the ore to 40 percent of manganese, none was marketed in the United States.

The ore is found in veins that occupy fissures in massive limestone. The veins strike N. 20° E. and dip nearly vertically; they are from 15 to 50 meters long, 7 to 30 meters or more deep, and 1 to 3 meters wide. The primary ore mineral is johannsenite, a manganese-bearing silicate having a radiating fibrous habit. When oxidized the mineral retains its habit but becomes light and porous from the loss of its silica. The primary ore is found at a depth of from 1.5 to 10 meters below the outcrops, and oxide ore seemingly cannot be expected to occur at a depth greater than 15 meters. Even in the deepest cut, which is 10 meters deep, most of the ore consists of primary silicate. The oxidized ore contains about 20 percent of manganese and as much as 30 percent of water, half of which, according to Mr. Arnold, is driven off at 105° C. and the rest at about 300° C. A rough sample taken from the stock pile of sorted ore gave the following composition: 35.4 percent Mn, 16.7 percent SiO_2, 5.6 percent Fe, 0.06 percent Al_2O_3, 0.04 percent Cu, 0.02 percent P, and traces of Zn, Pb, and S; 1.2 percent of the ore extracted was finer than 20 mesh.

About 50 tons of ore had been mined when the deposit was examined in 1943. Half was stock-piled at the highway and the rest at the mine, but none had been sold. The deposit is estimated to have reserves of about 5,000 tons of ore containing 30 percent of manganese, largely in the form of silicate. The high content of silicate and relatively low content of manganese, owing to the shallow depth of oxidation, combine to make this deposit unattractive.

HIDALGO

JACALA DEPOSITS (1)

Two manganese deposits, about 400 meters apart, are found not far from the Mexico City-Laredo highway, about 260 kilometers northeast of Mexico City and 6 kilometers east of Jacala. In 1942 a good road 2 kilometers long was built from the highway to the deposits, which at that time were controlled by Sr. Bourneman of Mexico City. The southernmost deposit was the more promising. At this deposit two exploratory cuts had been made, both about 15 meters long, 5 meters wide, and 7 meters deep. The ore occurs in chimneys in brecciated zones in massive limestone. The mineralized material consists of a diffuse replacement of the limestone by manganese oxides. The average manganese content of the material, which is fairly evenly mineralized, is estimated to be 20 percent, and it is therefore difficult to obtain high-grade ore by sorting.

About 1,000 tons of rock had been mined from the southern deposit. Most of this lay in the dumps when the property was visited in 1943, although some 50 tons of ore containing 35 percent of manganese had been sorted out and stored separately. The low grade of the ore and the relatively small reserves make these deposits of little commercial interest.

JALISCO

MEZCALA DEPOSITS (2)

A group of manganese deposits occurs near Mezcala, 15 kilometers north of Tepotitlán in northeastern Jalisco. The area is about 15 kilometers from the railroad, from which some of the deposits can be reached by road. In 1943 several claims in the area were owned by Adalberto Taylor of Guadalajara, among which were the Amparo (2e), Bertha (2b), Chiripa (2c), Palomas (2d), Concepción (2e), Elba (2f), Magdalena (2g), Murallas (2h), and Olga (2i). These had been leased to Rodolfo Aldape, who attempted to mine the deposits and sell the ore to the Metals Reserve Co. As the ore could not be sorted to 40 percent of manganese, work on the deposits had stopped by April 1943.

The area was not visited by the writers, but samples of the ore were examined. A report by Philip Chase of the Foreign Economic Administration states that near Mezcala several small veins were found in fissures in volcanic rocks, probably rhyolites. According to Martín Sutti (31) of San Luis Potosí, some of the deposits lie across the river from Mezcala; these are small and contain ore with less than 40 percent of manganese. According to Chase, most of the mineralized rock occurs in patches less than 15 centimeters in diameter. In a few places the ore forms 25 percent of the rock, but in general the tonnage of such bodies is small, presumably less than 1,000 tons, and the manganese content is only about 25 percent. Chase also stated that the best sorted ore contained from 37.8 to 50.7 percent of manganese and 0.4 to 9.6 percent of silica; F. M. Newton reported that some of the ore contained 52.8 percent of manganese, 1 percent of iron, and 4.1 percent of silica. Cuts less than 3 meters deep had been opened up when Chase visited the area in 1942, and some 25 tons of ore had been sorted out.

PROGRESO DEPOSIT (3)

The Progreso deposit is about 6 kilometers north of the Victoria deposit (Guanajuato 2), which is across the boundary line in Guanajuato. It is 40 kilometers from the railroad and 1 kilometer by trail from the nearest road. The deposit was controlled in 1943 by J. J. Falomir of Fomento Minero in Mexico City. An attempt was made to mine it late in 1942, but when the writers visited the area in May 1943, the property was idle, owing apparently to difficulty in obtaining a product that would meet marketing specifications.

The ore is found as lenses of manganese oxides in slaty shale, which strikes N. 60° W. and dips 15° to 30° SW. The deposit has been explored by means of two cuts 7 meters long, in which the ore body is 20 meters in length and averages 1 meter in width. The run-of-mine ore contains 25 or 30 percent of manganese. The manganese oxides presumably grade into rhodochrosite or rhodonite with depth. This deposit is similar to the Victoria to the south, and is in fact in more or less the same general line of strike. One hundred tons of ore are reported to have been produced, and about 10 tons estimated to contain 40 percent of manganese lay in a stock pile at the deposit in May 1943. Difficulty will probably be encountered in mining the deposit at a profit.

MEXICO

GUADALUPANA DEPOSITS (2)

The Guadalupana deposits are in the southwestern tip of the State of Mexico, about 15 kilometers north of Arcelia, Guerrero. They are probably the same as the so-called Tlalchapa deposit (2a) that is shown in the southwestern part of the State of Mexico on the Mexican manganese map (8). Although the area is served by a good road, the distance to the railroad, at Iguala, Guerrero, is 160 kilometers. For a year prior to May 1943, the deposits had been controlled and worked by the Cía. Minera La Guadalupana, of which Sr. Rafael Pous Cházaro of Mexico City was the principal owner. The area was examined by D. E. White (38) in December 1942, and by Trask in May 1943, when about 50 miners were working in the area.

The manganese deposits occur in silicified fracture zones in thin-bedded rhyolitic or latitic tuffs. These zones contain chimneys of ore that in general range to 80 meters in length and 5 meters in width, although the average width is only about 1.5 meters. The main Guadalupana deposit has four such lenses or chimneys. The general trend of the ore bodies is north-south, and the dip is 50° to 90° W.

The ore is composed mainly of manganese oxides, although a mineral that looks much like braunite is also present. An unknown manganese mineral, whose X-ray pattern, as determined by J. N. Axelrod of the Geological Survey, was different from all known minerals, was found in one specimen. Some bementite and a small quantity of neotocite occur in some of the ore. Silica is abundant in certain zones, and iron occurs with it in places, in part combined with the silica in the form of jasper and in part as iron oxides. Some of the silicified zones have been recrystallized. The abundance of silica requires that the ore be sorted carefully to keep the silica content below 15 percent. The ratio of sorted ore to run-of-mine ore is 1:2 or 1:3, although according to J. H. Ribgy, former operators maintained a ratio of 1 : 8 or 1 : 10. A representative sample from a pile of sorted ore ready for shipment gave 47.4 percent Mn, 12.0 percent SiO_2, 1.1 percent BaO, and 0.0 percent WO_3.

The main deposit had been explored by three cuts in a nearly north-south line. The northernmost cut is 80 meters long and 12 meters wide, and exposes two manganese zones, of which the westernmost averages 1.5 meters in width and contains 35 or 40 percent of manganese. This zone had been explored to a depth of 14 meters. The easternmost zone, explored in this same cut about 6 meters from the westernmost zone, is more siliceous and is estimated to contain about 20 percent of manganese and 15 percent of iron. It had been mined only slightly because of the leanness of its ore. About 30 meters to the south of this cut, another cut which is 40 meters long and 7 meters wide, was opened up. This cut exposes a zone averaging 1.2 meters in width, in which the manganese content is 35 or 40 percent. Another ore body of the same width lies 60 meters to the south of this cut.

Up to May 1943 some 1,000 tons of ore containing from 40 to 45 percent of manganese had been produced from the deposits. About 50 tons of ore lay in a stock pile at the mine; 100 tons were in a warehouse in Arcelia. Ore was customarily stored in Arcelia during the dry season, to permit continuing shipments during the rainy season, when the Alahuixtlán River is often too high to ford. Except for the long truck haul, which cost 35 pesos a ton in 1943, the deposits have good possibilities for production. Together with the Dulce Nombre deposit (2b), 400 meters to the north, the reserves are estimated to amount to 10,000 tons of ore containing about 40 percent of manganese and from 10 to 15 percent of silica.

Dulce Nombre deposit (2b).—The Dulce Nombre deposit is about 1 kilometer to the north of the Guadalupana deposits (2). It was controlled in 1943 by the Cía. Minera La Guadalupana y Anexas, S. A., and when visited in May of that year was being actively explored.

Two ore bodies are present. They lie in fissure zones transverse to the bedding of the tuff. One ore body is 25 meters long; the other, 15 meters farther east, is 35 meters long; both average 2 meters in width. They have been explored by two cuts, one striking N. 70° E. and the other due east, but no ore had been produced, as the exploratory work had not been finished.

María del Consuelo deposit (2e).—The María del Consuelo deposit is 20 meters to the south of the Chaca (2d), which in turn is 500 meters south of the Guadalupana deposits (2), some 18 kilometers by road north of Arcelia, Guerrero. In May 1943 the deposit was being considered for exploitation by Comercio General of Mexico City. The ore body measures 6 meters by 3 meters by 70 centimeters, and it tapers at either end. The ore is relatively richer in manganese than that in the Chaca deposit (2d), but its silica content is high and it closely resembles the ore in the Guadalupana deposits. The ore body had been fully explored by two open-cuts when the area was visited in May 1943, but no ore had been shipped. Reserves are estimated to be 50 tons of ore containing 15 percent of manganese and 15 percent of silica.

Tiempos Futuros deposits (2g).—The Tiempos Futuros deposits are 2 kilometers south of the Guadalupana deposits (2) and are 200 meters west of the road. They were controlled in 1943 by the Cía. Minera La Guadalupana y Anexas, S. A. The ore is found in chimneylike bodies in silicified zones in broken tuffs, as at the Guadalupana deposits. Six lenses from 3 to 15 meters long and 1 to 2.5 meters wide are found in a northwestward-trending zone 450 meters long and 125 meters wide. Small cuts had been made in each of these lenses. The ore is relatively high in silica. None had been shipped up to May 1943. Some 1,000 tons of material containing 30 percent of manganese are estimated to be present in the deposits.

NAYARIT

TEJABANES DEPOSIT (1)

The Tejabanes deposits is about 20 kilometers north of Hostotipaquilla and across the Santiago River. It was owned in 1943 by María Méndez and Teresa de Jesús Méndez, and was leased to F. M. Newton and T. F. Taylor. According to Martín Sutti (31), the deposit consists of zones of manganese oxides in vertical fissures in schists. Sutti regarded the deposits as of relatively small size. If the ore is in crystalline rocks, it will probably grade into manganese silicate or carbonate at depth. No ore had been shipped before May 1943, although three carloads had been mined and stock-piled at the mine. The long steep haul by trail makes the deposit costly to operate.

PUEBLA

PODEROSA DEPOSIT (1)

The Poderosa deposit is about 10 kilometers south of Huauchinango in northeastern Puebla, in the deeply dissected "barranca" region between the high central plateau and the coastal plain. It is at the base of a large waterfall at an altitude of about 1,500 meters above sea level. When the area was visited in May 1943, the deposit was owned by Manuel Vite, Antonio Estreganay, Luis Guillén Vite, Moises Vite, and Epigmenio Vite, all of Huauchinango. These gentlemen were attempting to develop and operate the deposit, but were having difficulty in meeting costs because of the low grade of the ore and the small size of the ore body.

The ore is in vertical stringers in horizontal layers of trachitic or rhyolitic agglomerate and tuff. The main vein strikes N. 30° E. and is at least 12 meters long and 8 centimeters wide, although its maximum width is as much as 1 meter. One adit 5 meters long had been driven into the hillside at an angle of 15° with the vein, and another was being started in the hope of finding a second vein. About 5 meters south of this adit another body of manganese ore crops out, possibly a continuation of the main vein. About 5 meters west of the main vein is a discolored zone containing perhaps 15 percent of manganese. This zone is at the base of an overhanging cliff that contains large loose boulders, which makes exploration difficult. This manganese-bearing zone does not extend into the overlying massive trachitic bed. Several small stringers of manganese ore are also found in other places. The ore in the narrow stringers contains about 45 percent of managanese, but the over-all grade of the ore zones is probably less than 25 percent of manganese. Some 30 tons of 25-percent ore lay in a stock pile beside the main workings in May 1943.

CUAJILOTE DEPOSIT (8)

The Cuajilote (Guajilote or Xuajilote) deposit is 20 kilometers south of Acatlán, on top of an old upland surface about 250 meters above the Petlalcingo River. It is mentioned in the Mexican manganese report (8) as the Petlalcingo deposit. It is said to have been controlled in 1942 by Mr. James B. Tanney of New York City; it was later operated by a Señor Traslajeros, who reportedly disposed of his interests in April 1943 to Sr. David Mujaes of Mexico City, who in May 1943 was operating the mine. The ore was shipped by truck to Matamoros, about 100 kilometers distant, for the most part over a good paved highway. The truck rate to Matamoros was reported as 25 pesos a ton; the freight rate from there to Laredo was 30 pesos a ton. According to C. E. Pouliot (26), who visited the deposit in March 1943, approximately 80 men were working on the property; the daily production amounted to 10 tons of ore containing 42 percent of manganese. In May 1943 only 10 men were working in the mine, and the operator was having difficulty in trucking the ore.

The deposit is found in a northwestward-trending zone in nearly vertical schists. It apparently consists of three ore bodies within a distance of 500 meters. These bodies are parallel to the schistosity of the country rock and are cut by many quartz veins, which are composed of crystals as much as 1 millimeter in diameter. The largest ore body is at the edge of a cliff overlooking the Petlalcingo River, where it is exposed in a cut 20 meters long, 6 meters wide, and 10 meters deep. The width of the ore body is variable; 3 meters may be the average. A length of 10 meters seems to be all that is warranted for the ore body, as the cut narrows toward the north and the ore probably does not extend far beyond its south end, judging by the small quantity of float found on the surface. About 300 meters southeast of the north cut another cut had been opened that was 15 meters long and 7 meters deep. This cut is elongated toward the northwest and exposes an ore body whose maximum thickness is 2.5 meters, but which averages only 1.5 meters. Some 200 meters farther to the south a third cut had been opened for a length of 10 meters and to a depth of 5 meters. The ore body exposed in it has an average width of 1 meter. As little manganese ore is found as float on the surface between these three cuts, the ore bodies are believed to be lenticular and discontinuous.

The ore in the deposit consists of a mixture of manganese oxides and a dense hard mineral that looks like braunite. The average grade of the ore in the north ore body is only about 25 percent in manganese, which necessitates sorting by hand to bring the grade to 40 percent. A sample of sorted ore from this body contained 38.4 percent of manganese, 33.2 percent of silica, and 0.02 percent of tungstic oxides; no barium was found. The middle ore body contains materials of about the same grade as that in the north ore body, but the south ore body is somewhat leaner.

Total production from the deposit is said to have amounted to 1,000 tons of ore, of which about 125 tons lay in a stock pile at the north mine in May 1943. Reserves in the area are estimated to amount to 5,000 tons of ore averaging about 25 percent of manganese, of which the greater part is in the north ore body.

SAN LUIS POTOSÍ

MONTAÑA DE MANGANESO MINE (1) [6]

The Montaña de Manganeso mine, one of the most famous manganese mines in Mexico, is 80 kilometers by road west of Charcas and 4 kilometers southwest of the small village of Santo Domingo (Ranchito), in San Luis Potosí. Charcas is on the Laredo-Mexico City line of the Ferrocarriles Nacionales de México. The mine may be reached either from Charcas to the east, Salinas to the south, or Villa de Cos to the southwest. The roads by these routes are unimproved and traversable with difficulty when wet.

The mine is owned by Sr. Aureliano de Leon of Mexico City and is operated by the Cía. Minera Adeleón, S. A., under the direction of Mr. T. W. Callahan, who has offices in Charcas, San Luis Potosí. The mine was first operated during World War I and more or less continuously since then. Until World War II, most of the ore was shipped to the steel mill at Monterrey, Nuero León, operated by the Cía. Fundidora de Fierro y Acero de Monterrey, S. A. In 1942 some ore was shipped to the Metals Reserve Co. at Laredo, Tex., but most of that mined between 1942 and 1944 went to the Sheffield Steel Co.

[6] Description of Montaña de Manganeso mine (1), exclusive of the Cruz deposit (1b), has been written by Ivan F. Wilson and Victor S. Rocha.

and to the Tennessee Coal and Iron Co. About 20 men were working on the property in June 1944.

Production figures are not available for the years prior to 1923, including the World War I period, when probably at least 5,000 tons of ore was produced. Published figures for the period 1923–33 report a total production of 11,912 tons of ore for that period. (See table 10.) No data are available for the period 1934–41, but from January 1942 to June 1944, some 5,000 tons of ore were produced. Hence the total production to June 1944 was probably between 20,000 and 25,000 tons, although the total to March 31, 1945, as given in table 17, is only 19,000 tons. The rate of production in June 1944 was estimated to have been from 190 to 200 tons a month. The Montaña de Manganeso mine is thus the third largest producer of manganese ore in Mexico, ranking after the Lucifer (Baja California 4) and Talamantes (Chihuahua 31) deposits.

TABLE 10.—*Production of manganese ore from the Montaña de Manganeso mine (San Luis Potosí 1), 1923–33*

[Compiled from Anuario de Estadistica Minera, 1925–38]

Year	Production (in metric tons)	Year	Production (in metric tons)
1923	1,250	1929	650
1924	1,800	1930	732
1925	2,700	1931	731
1926	1,648	1932	306
1927	861	1933	573
1928	661		

Montaña de Manganeso is a prominent, isolated rocky hill formed of resistant jasper. It rises 40 meters above the general level of the surrounding plains, which are at an altitude of about 2,000 meters. The hill is 200 meters long and 100 meters wide, but the manganese deposits are scattered over an area 600 meters long. The flanks of the hill and surrounding plains are underlain by fine-grained, thin-bedded, white to buff, clayey tuffs, which are covered for the most part by alluvium and alliche but are exposed in some of the mine workings.

The tuffs have been silicified and replaced by massive jasper and siliceous manganese ore along a northward-trending fissure zone. Jasper crops out prominently on Montaña de Manganeso. It occurs within a belt 50 to 120 meters wide and at least 700 meters long, which probably extends even farther beneath the alluvium. The jasper usually is red, although some of it is green or, in many places, stained black by manganese oxides. The jasper belt is parallel to the bedding of the tuffs, which have a general strike of N. 25° E. and a dip of 50° NW. In the mine workings several small high-angle faults may be observed, most of which dip from 70° to 80° to the east or west and strike northeast, parallel to the jasper belt, although a few strike northwest or west.

The manganese ore occurs in chimneylike bodies and irregular masses within the jasper and, in part, adjacent to the tuff. The bodies are irregularly distributed, and many of them are bounded on one or more sides by faults. In many places the contacts with the jasper are not sharp, but consist of a gradation from siliceous manganese ore into a jasper containing small quantities of manganese oxides. The chimneylike bodies have average dimensions of 5 to 10 meters in width and 10 to 25 meters in length, and most of them have been bottomed at depths of 20 to 30 meters. Veinlets of manganese oxides extend from the main bodies into the surrounding tuffs and jasper. The distribution of the ore bodies and mine maps of the most important workings are given in the detailed report by Wilson and Rocha.[7] The dimensions of the workings and the features of the principal ore bodies are summarized in table 11 of the present report.

TABLE 11.—*Descriptions of eight workings in the Montaña de Manganeso mine (San Luis Potosí 1)*

Working name or No.	Extent of development	Nature of ore body
Cueva	Irregular stopes and pillars extending to a depth of 34 meters. Area about 20 by 30 meters, but variable at different levels. Open to surface, by open-cuts and a short drift.	Irregular chimneylike body about 20 meters in diameter and 34 meters deep. Cut by several faults. Softer ore mined out; large pillars and irregular masses of siliceous ore remain. Most of ore produced in World War I and succeeding years came from here.
Mezquite	Irregular stopes 30 meters long, 5 to 10 meters wide, and 5 to 10 meters high extend to a depth of 21 meters. Short drift near top connects to surface; also connection 12 meters lower, by adit 20 meters long.	Irregular chimneylike body. In places offset 2 to 3 meters by faults. In fault contact with tuff to southeast. Most of softer oxide ore mined out; pillars of hard siliceous ore remain.
No. 2	Open-cut, vertical shaft, inclined shaft, and stopes at 19.5-meter level.	Chimneylike body in main stoped area was 15 meters long, 5 meters wide, and 4 to 5 meters high. Also other bodies of ore. Many faults. Mostly siliceous ore left.
No. 3	Drift 42 meters long	Driven from west side of hill to reach Mezquite ore body, which had not been reached in June 1944. Few pockets of manganese oxides in jasper in face of drift.
No. 4	Shaft 28 meters deep; drifts at 23-meter and 28-meter levels.	Chimneylike body about 4 by 10 meters and bottomed at 28 meters. Siliceous ore remains in northwest face.
No. 5	Two shafts, 6 and 14 meters deep; short drifts at −14 meters.	Main ore body 15 meters long, 5 meters wide, and bottomed at 14-meter level. Hard ore remains in some of walls. Many intersecting faults.
No. 6	Open-cut 8 meters deep; drift 23 meters long at −6.8 meters.	Ore body about 8 by 5 meters, mined from open-cut. Drift penetrates alternating jasper and siliceous manganese ore.
No. 8	Shaft 11.9 meters deep; drift 17 meters long at bottom.	No ore encountered to June 1944. Object was to reach ore body exposed in open-cut to south.

[7] Wilson, I. F., and Rocha, V. S., Manganese deposits of Montaña de Manganeso mine, San Luis Potosí, Mexico: U. S. Geol. Survey Bull. (in preparation).

The chimneylike ore bodies have been worked chiefly by means of shafts and irregular stopes. Some of the older workings were even more irregular, particularly the largest one, called the "cueva" (cave). In the past, the ore was carried to the surface on the backs of the miners, who followed very tortuous paths and utilized "chicken ladders" (notched poles), but the present operators employ vertical shafts and hoists.

The deposits consist mainly of a very hard, massive, siliceous manganese ore, in which occur irregular pocketlike and chimneylike bodies of softer manganese oxides. This softer oxide ore has been mined selectively, and the larger masses of harder siliceous ore have been left as pillars. The hard ore consists mainly of braunite, containing patches of brown opal and quartz with inclusions of finely disseminated manganese oxides. The softer ore is composed of pyrolusite and manganite. All gradations occur between the hard and soft types of ore. Through a series of 15 X-ray determinations J. M. Axelrod has identified the minerals listed in table 12. The minerals are given in their approximate order of abundance.

TABLE 12.—*Minerals found in the Montaña de Manganeso (San Luis Potosí 1) ore*

Mineral	Composition	Appearance
Braunite	$3(Mn,Fe)_2O_3.MnSiO_3$	Dark gray to black, massive, smooth surface.
Pyrolusite	MnO_2	Lighter gray, massive, rougher surface.
Manganite	$MnO(OH)$	Brown, massive or crystalline.
Unidentified manganese mineral.		Traces found with braunite and opal.
Opal [1]	$SiO_2.nH_2O$	Brown, massive, glassy to pitchy luster.
Quartz	SiO_2	Brown or pink, glassy, massive crystalline.

[1] Material that gives a moderately diffuse pattern similar to that of cristobalite is here called opal.

The grade of the ore shipped has ranged from 38 to 43 percent of manganese, and has probably averaged 40 or 42 percent. The silica content reportedly averaged about 17 percent. Lower grade, higher silica ore has been sorted out at the mine or left in the mine workings. Assays of a series of seven samples taken from the mine workings by Wilson and Rocha are given in table 13. A sample collected by Trask and analyzed by Michael Fleischer, of the Geological Survey, contained 46.0 percent Mn, 33.2 percent SiO_2, 0.2 percent BaO, and 0.02 percent WO_3.

The deposits are thought to have been formed by ascending solutions that deposited manganese mineral and silica along chimneylike channels and fissures, partly replacing some of the tuff. Many of the deposits appear to have been localized by faults. It is thought likely that the original manganese mineral deposited was braunite and that the manganese oxides—pyrolusite and manganite—were formed by oxidation along irregular channels near the surface.

TABLE 13.—*Partial chemical analyses of manganese and silica in samples of Montaña de Manganeso (San Luis Potosí 1) ore*

[Analyses by Crédito Minero y Mercantil, S. A., México, D. F.]

Sample No.	Manganese (percent)	Silica (percent)	Location of sample and remarks
1	43.3	22.0	Mezquite. Pillar opposite main entry tunnel. Horizontal sample over width of 5.5 meters. Pillar is nearly 10 meters high. Hard ore.
2	46.0	17.8	Cueva. Wall at north end of main stope, opposite entry tunnel. Hard ore containing some seams of soft oxide. Sample, 2.7 meters wide.
3	50.1	11.6	Cueva. Level, 30 meters at southwest end. Mostly hard ore. Sample, 2.0 meters wide.
4	45.5	20.8	Shaft No. 4. Level, 23 meters at northwest wall. Hard ore containing pockets of opal and quartz. Sample, 4.7 meters wide.
5	40.6	28.8	Mine No. 2. North wall, near top of entrance. Hard ore. Sample, 4.9 meters wide.
6	35.1	37.0	Mine No. 2. Bottom at west end. Hard ore containing pockets of opal and quartz. Sample, 3.2 meters wide.
7	42.7	23.4	Mine No. 5. Bottom of shaft, at west wall. Hard ore. Sample, 3.6 meters wide.

Most of the visible bodies of soft manganese oxide ore had been mined out by June 1944, but as many of the bodies do not crop out at the surface, others may possibly be uncovered by underground exploration. A considerable tonnage of hard siliceous ore remains, which requires careful sorting to obtain a product with less than 20 percent of silica.

Cruz deposit (1b).—The Cruz deposit is 1 kilometer south of the Montaña de Manganeso, on the flat plain eroded in rhyolitic rocks. It was owned in 1943 by Martín Sutti and was operated by Geoffrey Wastenys. In May of that year it was almost mined out and operations were abandoned. During the previous 12 months, some 1,000 tons of ore were said to have been produced from the deposit and sold to the Metals Reserve Company. The grade of this ore was 44 percent Mn, 3.5 percent Fe, and 9 percent SiO_2.

The deposit consists of a lenticular ore body 20 meters in diameter and 1.2 meters in average thickness, which lies in the projection of the strike of the lenses in the Montaña de Manganeso deposit. The ore consists of the replacement, in a nearly circular area, of a flat-lying tuffaceous bed. The ore body was less than 5 meters from the surface and contained more manganese and less silica than the ore from the Montaña de Manganeso mine. Several holes were drilled into the caliche-covered flat on the general projection of the Montaña de Manganeso lenses, both to the north and south of the Cruz ore body, in the hope of finding other mineralized zones, but none was found. Additional prospecting between the Cruz and the Montaña de Manganeso deposits might disclose additional lenticular ore bodies, but the presence of the caliche makes prospecting difficult. Geophysical methods might be helpful.

SAN ANTONIO DEPOSIT (3)

The San Antonio deposit is 8 kilometers west of Salinas on the railroad between the cities of San Luis Potosí and Aguascalientes. It was owned in 1943 by Francisco Alfaro and José A. Guzmán of Salinas. The deposit consists of a chimney of manganese ore in a silicified zone in rhyolitic flows and tuffs. The ore body is slightly more resistant to erosion than the surrounding country rock and rises as a hill about 100 meters above the adjacent plain. Two lenses of manganese ore are present: one is 6 meters long and 1 meter wide, the other is 5 meters long and 1 meter wide. Two cuts about 5 meters in diameter had been made in the two ore bodies, but no ore had been produced. Probably less than 1,000 tons of ore containing 30 percent of manganese and 25 percent of silica are present. The reserves of good ore are relatively small.

VICTORIA DEPOSIT (4)

The Victoria deposit is about 6 kilometers northeast of Guadalcázar in the northeastern part of the State of San Luis Potosí. It is reached by trail from Guadalcázar, which is 14 kilometers by poor road and then 78 kilometers by paved road from the city of San Luis Pótosí. It can be reached also from Villar to the south, on the railroad from Tampico to San Luis Potosí, by means of a trail about 20 kilometers long which passes through Guadalcázar. The deposit was owned in 1943 by Raúl Oliva of San Luis Potosí. It had not been worked since 1942.

The ore is found in a breccia zone in limestone, about 15 meters from the contact between this rock and a small granitic stock. The principal mineralized zone is a chimney 50 meters long and 2 meters in average width, which extends vertically to an unknown depth. In one place it is beside a fine-grained porphyry dike about 15 centimeters thick. The ore consists largely of manganese oxides and probably contains very little silica. The average manganese content is about 20 percent, which requires that the ore be sorted carefully to obtain a marketable product. Several cuts had been made into this zone, but in 1943 these were largely filled with material that had been washed in by the heavy summer rains. One of these cuts is said to have been 20 meters deep. About 30 meters north of the outcrop of the chimney, an inclined shaft 30 meters long had been sunk to intersect the ore at depth, but no ore was found in the shaft.

A deposit similar to the Victoria was reported about 800 meters farther up the creek, adjacent to the granitic stock, but it was not visited because the guide did not know the exact location. Several smaller deposits were reported to occur in other places near the stock, but none had been mined because of the low grade of the ore.

Some 40 tons of ore from the Victoria deposit lay in a warehouse in Guadalcázar in 1943. This ore contained only 30 percent of manganese, and none had been shipped. About 300 tons of fine washings estimated to contain 20 percent of manganese lay in the dumps at the mine. This material had been run through a jig, but apparently almost no concentration had been effected. The relatively small size of the ore bodies in this area and the low manganese content of the ore makes these deposits unpromising.

SONORA

INDEPENDENCIA DEPOSIT (2)

The Independencia deposit is 4 kilometers southeast of Nogales, Sonora. It was owned in 1943 by T. J. Anderson of Nogales, Ariz., and was said to be controlled by the Cía. International Mines. When visited in June 1943, it was being operated by three men. The deposit is in granitic rocks, in a fissure zone that crops out intermittently for several hundred meters, but the largest single continuous exposure of this zone is only 60 meters long and 40 centimeters in average width. The ore body strikes nearly east and dips vertically. It had been explored by means of two cuts. No ore had been marketed, but some 10 tons estimated to contain 35 or 40 percent of manganese, 10 or 15 percent of silica, and about 8 percent of iron lay in a pile beside the workings. The reserves are believed to be relatively small.

CARR DEPOSITS (3)

The Carr deposits are 20 kilometers southwest of Agua Prieta and are about 6 kilometers south of the International Boundary. They were first mined during World War I. In 1943 they were owned by James P. Carr of Cananea and Hal P. Forester of El Paso, Tex. About 20 men were working on the property when the mine was visited in March 1943.

The deposits consist mainly of three mineralized zones in thin-bedded, fine-grained limestone believed to be of Mesozoic age. In a short distance along its strike, this limestone grades into a breccia composed of roughly rounded limestone fragments. The region has been highly faulted, and these deposits appear to be in a downthrown block 150 meters in width. The ore zones apparently occur within a stratigraphic interval of 30 meters, separated by beds of barren limestone, but the aggregate thickness of each is only about 2 meters, of which from 30 to 60 centimeters consists of ore. The mineralized zones have been explored and mined by means of three shafts as much as 25 meters deep, and by associated underground workings and several surface cuts. The shafts pass through a surficial mantle of detritus and caliche, and the ore is extracted from drifts driven into the underlying ore bodies. Another mineralized zone, about 120 meters long, occurs some 100 meters to the north of the main zone.

It is in limestone breccia that strikes N. 70° W. and dips 40° N. This zone is offset 7 meters by a fault near its east end. It has been explored by two cuts 15 meters long and an adit that was being driven in 1943. The principal manganese mineral in the deposits appears to be braunite, and the silica content, estimated to be about 10 percent, is thus somewhat higher than that in clean oxide ores.

Production from the area during World War I amounted to some 2,500 tons of ore, which was extracted from the north ore body. Although this body seems to be largely mined out, the region affords some possibilities and geologic mapping would aid materially in locating additional ore. Perhaps as much as 10,000 tons of ore containing 40 percent of manganese may remain in the deposits, but as the structure in the area is complex, the ore bodies may not be so continuous over the entire basin as has been assumed.

GAMER DEPOSITS (5)

Several deposits of rhodochrosite, the Shangrilá (5a), San Antonio (5c), Victoria (5d), Spirit 1 and Spirit 2 (5e) claims may be found in the mountains 32 kilometers by airline and 45 kilometers by mountain road east of Imuris. They are in a region of complex faulting and mineralization. Many silver, lead, and gold veins were worked in this region during the time of Porfirio Díaz, but without much success. The gangue in many of these veins consists of manganese oxides near the surface, and of rhodochrosite at depth. In 1943 William L. Gamer of Magdalena acquired some of these deposits and began to work over the old dumps for manganese ore. Both oxide and rhodochrosite ore were recovered and sold, the latter mainly to the William Carus Co.

In the fall of 1942 and spring of 1943, Mr. Gamer sank a 25 meter shaft at the Shangrilá (5a) claim, on a vein of manganese oxide ore, which at depth gave way to ore composed of coarsely crystallized pink rhodochrosite and quartz. The ore is about half rhodochrosite, and its manganese content averages about 25 percent. The vein has an average width of only 30 centimeters and is not a promising ore body.

Production from the area has amounted to some 500 tons of ore, most of which was of chemical grade. The reserves appear to be small. The operator was having difficulty in finding marketable ore in June 1943, and it was probable that operations would soon cease.

Shangrilá claim (5a).—About nine men were working on the Shangrilá claim when it was visited in June 1943. The shaft began in a series of argillites, some 6 meters northeast of the outcrop of a body of manganese oxides. This ore body strikes N. 50° E. and dips 60° NW., and at the surface is half a meter wide. At a depth of 12 meters in the shaft, a vein consisting of rhodochrosite, quartz, calcite, and several sulfide minerals was encountered. The shaft was continued to a depth of 25 meters, where a drift was driven for 15 meters along the vein, which was found to have a maximum width of 60 centimeters. The ore body appears to pinch out toward the north. The ore in the outcrop contains 22 percent of manganese, and a sample from the best part of the vein, near the bottom of the shaft, gave 32 percent of manganese. The rhodochrosite must be sorted by hand to raise the grade of ore to a marketable level. Perhaps as much as 100 tons of rhodochrosite concentrate have been produced from this shaft and drift.

San Antonio (5c), Victoria (5d), Spirit 1, and Spirit 2 (5e) claims.— The San Antonio, Victoria, Spirit 1, and Spirit 2 claims are about 3 kilometers northeast of the Shangrilá (5a) and are reached by a road that follows the river bed. They were owned by William L. Gamer in June 1943, but work on them had ceased several months before. The manganese ore is found as gangue in silver, lead, and gold veins, in a complex series of argillites and tuffs. The veins strike northeast, in general, and dip nearly vertically; they range up to 60 meters in length and 1 meter in thickness, although the average thickness is only 60 centimeters. About 400 tons of rhodochrosite ore had been sorted out of the old dumps and sold to the William Carus Co. for chemical purposes.

ANTILLAS DEPOSIT (6)

The Antillas deposit is 3 kilometers west of Magdalena, which is 90 kilometers by road or railroad south of Nogales, on the international boundary. It was first mined during World War I, and a detailed description of the old workings has been given by Ingeniero Teodoro Flores (1929b) of the Instituto de Geología. In 1943, the deposit was owned by Juan Antúnez of Santa Ana and was operated by the Explotadora Mexicana de Manganeso. About 10 men were working on the property when it was visited in March 1943.

The deposit is located along a shear zone between gneiss and schist. This zone trends northwest and dips 65° to 80° N. Three lenses of ore are in this zone in a horizontal distance of 250 meters. The largest of these, the middle one, has been explored to a depth of 15 meters in one cut and for a horizontal distance of 150 meters in several trenches. Its width varies from 1 to 2.5 meters. The southeast lens is about 50 meters long and has been explored by means of a shaft 6 meters deep. The ore from the middle lens is the richest and averages 35 percent of manganese; that from the other two lenses averages 20 or 25 percent of manganese. All the ore must be sorted carefully to bring the grade up to 40 percent.

The deposit yielded some 3,000 tons of ore during World War I and some 200 tons during the recent period of mining—to March

1943. A large dump containing about 3,000 tons of ore lay beside the middle ore body when the area was visited, and another dump of 200 tons lay beside the northwest ore body. Reserves are estimated to be 10,000 tons of ore containing 30 percent of manganese. Because of the low grade of this ore, it is doubtful whether the deposit can be mined profitably.

GUADALUPANA DEPOSITS (8)

The Guadelupana deposits are 5 kilometers by trail from the road and 45 kilometers from the railroad at Magdalena. They are 12 kilometers southeast of the Dardanelas deposit (7). In 1943 they were owned by Roberto Gallego of Magdalena, and in March of that year were being operated by George W. Greenwood. At that time five men were mining the deposits.

The country rock in the area consists of gently inclined rhyolitic and andesitic flows and tuffs, which are underlain by vertical, contorted, dark-gray clay shales that look much like the shales of the Knoxville formation of California, of Jurassic age. All these rocks are disturbed by faults. The manganese ore occurs in veins in fissures that trend N. 15° to 30° E. and dip 70° to 80° W. The veins are as much as 60 meters long and 1.2 meters wide, though generally they are less than 60 centimeters wide. Four main veins are found on the Guadalupana property, within a horizontal distance of 50 meters. These vary markedly in width along their course. The ore consists of black calcite and manganese oxides, and its average manganese content is about 35 percent. A sample of sorted ore contained 47 percent of manganese, 8 percent of silica, and 4 percent of iron. Production up to March 1943 amounted to approximately 50 tons of ore, besides 40 tons that were on the dumps at the mine when the area was visited. Reserves are not large.

Ojo Negro deposit (*8d*).—The Ojo Negro deposit is 2 kilometers northwest of the Guadalupana deposits (8), along a fault between rhyolite and tuff. It has been explored by one cut 6 meters long. The ore is relatively low in grade, averaging about 20 percent in manganese, and the deposit offers little promise of yielding much ore commercially. Southeast of this ore body, stains of manganese oxides are found on the face of a scrap along the same fault. Farther to the southeast, about 1 kilometer from the Ojo Negro deposit and in the general projection of its ore body, a series of manganese-bearing lenses occurs along a fissure zone. These lenses are found over a distance of 60 meters, on both sides of a sharp divide between two streams. They strike N. 20° W. and dip steeply to the southwest and have been explored by means of three cuts, one of which is 6 meters long. The grade of the ore in these lenses is about 20 percent in manganese, as in the other veins. The ore reserves are small.

ZACATECAS

HÉRCULES DEPOSIT (1)

The Hércules deposit is 3 kilometers north of San Pedro Ocampo, in the northeastern tip of Zacatecas. It is 20 kilometers by road and trail from the railroad, which ends at San Pedro Ocampo. When the area was visited in April 1943, the deposit was owned by the Agencia Minera of Saltillo, Nuevo León, and was being operated by Leopoldo Villareal, Jr., also of Saltillo. At that time the deposit was being mined by ten men.

The deposit is at an altitude of 2,280 meters above sea level, or 360 meters above the town of San Pedro Ocampo. The ore occurs in massive limestone that strikes east and dips 45° N. This limestone is about 1,500 meters thick and consists of fairly massive beds near the top, which gradually become thinner and metamorphosed with depth. The ore is found in a chimney, which is elongated in an easterly direction and dips vertically. It is about 25 meters in length and 3 meters in average width. A few quartz veins less than 1 centimeter in thickness cut through the chimney. In April 1943, one cut 6 by 3 meters in area had been opened in the ore body. The ore is a mixture of manganese oxides and a mineral that looks like braunite. It is associated with yellow jasper, although no intrusive body from which the jasper might have been derived was found nearby. The average manganese content of the ore is 20 percent; difficulty is encountered in raising the grade to 40 percent by sorting.

The mine had yielded 20 tons of ore containing 40 percent of manganese up to April 1943, and about 10 tons of selected ore estimated to contain 30 percent of manganese was stock-piled beside the workings. Because of the small size of the ore body and the low grade of the ore this deposit does not offer good commercial possibilities.

TINAJA DEPOSIT (5)

The Tinaja deposit is 10 kilometers by airline east of Gutierrez and 14 kilometers south of Cañitas, from which it is reached by a road 18 kilometers in length. It was owned in 1943 by Ramón Molleda of Cañitas and was said to have been leased to Erle P. Halliburton of Los Angeles, Calif. About 20 men were working on the property when the area was visited in May 1943.

The deposit consists of manganese-bearing chimneys in silicified rhyolitic tuffs and agglomerates at the northwest end of a low hill. It was being explored by a series of vertical shafts from 3 to 12 meters deep, over a distance of 200 meters in the durection N. 60° W., which is the general trend of the hill. The largest ore body has dimensions of 30 by 15 by 1.5 meters. The ore consists principally of a mineral that looks like braunite, mixed with a large proportion of crystalline silica. Much yellow and red jasper are present in some of the ore, and the proportion of iron may be high. Only a few small pockets of manganese oxides had been found at the time the property was visited, but the operator believed that oxides would be encountered in greater abundance at depth, for the ore in the Manganita deposit (6), 40 kilometers to the northeast, became richer in oxides at depth. The average grade of the ore is estimated as 20 percent in manganese, and the ratio of siliceous ore to manganese oxide ore is about 10:1, which is among the highest of the ratios observed in the deposits in this general region.

Up to May 1943 no ore had been produced from the Tinaja deposit. Reserves are difficult to estimate because of the variable nature of the mineralized rock.

MANGANITA DEPOSIT (6)

The Manganita deposit is among the best of the manganese deposits in Mexico, and has been mined ever since World War I. It is 35 kilometers east of Cañitas. In 1943, it was owned by Aureliano de León and was operated by the Cía. Minera Manganita. The original Manganita claim included the present Manganita and Mezquite properties on the northeast end, and the Humo de Oro and Cerrito properties on the southwest. All of these are now combined into the Expansion de Manganita claim.

The deposit consists of three mineralized zones in silicified rhyolitic tuffs. The general strike of the ore bodies is N. 70° E. and the dip is 50° to 60° S. The ore body at the east end of the original Manganita claim consists of a lens about 60 meters long and from 1.5 to 3 meters wide, averaging about 2.5 meters in width. The ore is composed of a hard dark mineral that looks like braunite and is mixed with manganese oxides in the ratio of five parts of braunite to one of oxides. The percentage of oxides tends to increase with depth. The average manganese content of the ore is estimated to be 40 percent and the silica content 15 or 20 percent. As the ore body is mined by hand, operations cease at the water level, which is at a depth of 15 meters.

The Mezquite property is 30 meters N. 60° W. from the east ore body in the Manganita claim. It contains a mineralized zone that strikes east and dips 70° S., this zone is 60 meters long and from 1 to 2.5 meters thick. The ore is hard and siliceous near the surface but grades into softer manganese oxides with depth. The tenor of this ore body is similar to that of the east ore body. About half the oxide ore in this lens has been mined out.

The best ore body in the Manganita deposit is at the west end of the area, more than 1 kilometer from the east ore body. It occupies a zone 150 meters long and from 2 to 6 meters wide. This zone has been explored to a maximum depth of 12 meters, where the ore body was found to widen to 6 meters. At the surface the ore consists mainly of braunite(?) mixed with a small proportion of neotocite, a hydrous manganese silicate, but in the bottom of the workings at the east end of the lens, for a distance of 30 meters along the strike, the braunite(?) gives way to manganese oxides mixed with a large proportion of calcite.

The Manganita deposit has yielded about 3,500 tons of ore, mainly from the west ore body. Some 50,000 tons of ore containing 40 percent of manganese and 10 or 15 percent of silica are estimated to remain in the deposit.

ABUNDANCIA MINE (7) [8]

The Abundancia deposit, also called the Colorada, was newly discovered and mined during World War II. It is 40 kilometers by road east of La Colorada, a station on the Ciudad Juárez-Mexico City line of the Ferrocarriles Nacionales de México, but is reached by automobile more easily from Zacatecas City, by way of Villa de Cos. It is in a region of nearly flat plains, at an altitude of about 2,000 meters above sea level.

The mine is owned and operated by the Cía. Minera Central, S. A., under the direction of Sr. Luis Madero of Mexico City. Exploration and mining began in 1942. According to the operators, up to the end of 1942 the deposit had yielded 5,000 tons of ore that averaged approximately 42 percent of manganese and up to May 1944 a total of about 12,000 tons. Most of this ore was shipped to the Metals Reserve Co. at El Paso, Tex. About 70 men were employed on the property in May 1944.

The ore is enclosed in thin-bedded, white to buff, tuffaceous clays, which are very fine grained and generally soft. Near the ore bodies these clays have been silicified and contain lenticular masses of jasper. The strike of the beds curves from N. 70° W. in the eastern workings, to M. 70° E. in the western workings, and the dip averages 25° S. but is variable in detail. In the southern mine workings the dip flattens and local anticlinal structures are present. Two small normal faults striking N. 70° W. and dipping 65–75° SW. drop the ore down from 1 to 3 meters on the southwest side.

The ore has been followed down the dip and stoped out in irregular workings of the room-and-pillar type; up to May 1944 it was carried to the surface on the backs of the miners. Ten shallow shafts had been sunk. Data concerning their depth and the levels at which ore was encountered are given in table 14, in which the shafts are listed in order from west to east.

[8] Description of Abundancia mine has been written by Ivan F. Wilson and Victor S. Rocha.

TABLE 14.—*Description of shafts in the Abundancia manganese mine (Zacatecas 7)*

Shaft No.	Altitude at surface, in meters [1]	Depth of shaft, in meters	Remarks
6	2004.5	7.1	In tuffaceous clay; not deep enough to reach ore.
5	2003.8	8.9	Ore at 6.2 meters.
4 viejo	2004.1	9.7	Ore at 6.2 meters. Bottom of shaft was 1 meter deeper, but has been filled in by waste.
4 nuevo	2003.4	12.2+	Ore at 6.35 meters; water at 12.2 meters.
41	2003.6	12.4+	Ore at 6.9 meters; water at 12.4 meters.
23	2004.9	4.1	Short drift at bottom; very little ore.
1	2003.6	10.0	Ore at bottom.
2	2003.9	13.8+	Ore between 10.7 and 13.7 meters; water at 13.8 meters. Used as water well.
21	2003.8	6.4	Ore at 4.1 meters.
22	2003.7	5.0	Ore at bottom.

[1] Starting point for survey was assumed to be 2,000 meters.

The manganese ore occurs in lenticular bodies that roughly follow the beds of clay and only locally cut across them. The ore pinches and swells along both the strike and dip, and in places wedges out into thin lenses intercalated with clays. Thin veinlets of manganese oxides extend from the main ore body into the adjacent wall rock.

The average thickness of the ore bodies is from 1 to 2 meters, ranging from less than half a meter along the thin edges of the deposit, to more than 5 meters as in the vicinity of shaft 4 "nuevo." There the ore bulges into a chimneylike body in an anticlinal structure in the clays. The main ore body, between "boca mina" 1 and "boca mina" 4, has a length of 120 meters along the strike and a width of 42 meters down the dip. A greater width down the dip is to be expected, but work in that direction had been temporarily halted in May 1944 because of an excess of water at a depth of 12 meters. The operators were expecting to carry on exploratory work along the strike, both to the east and west.

Another deposit had been found in "boca mina" 2 and shafts 2 and 21, north of the main ore body. This deposit had been explored for 35 meters along the strike and 24 meters down the dip, where further exploration had been halted in May 1944 by the presence of water. If this ore body should continue much farther to the south, it would pass below the main ore body, although the alternate possibility exists that the two deposits may represent faulted segments of the same ore body. On the west wall of the open cut at "boca mina" 2, the ore consists of two lenses, the upper one 2.0 meters thick and the lower one 1.3 meters thick, separated by 1.6 meters of clay.

At mine 3, 60 meters N. 67° E. from shaft 21, a siliceous ore body was explored by means of a small open-cut and a short drift, but work was abandoned because of the high silica content of the ore. This is probably a separate ore body not connected with those in the main workings.

Part of the ore in the Abundancia deposit consists largely of soft manganese oxides, and the rest of hard siliceous rock. As the two types occur in separate, moderately well defined masses, the softer ore has in many places been mined selectively and the hard ore has been left in the form of pillars. A series of 15 X-ray determinations made by J. M. Axelrod has resulted in the identification of the following minerals: pyrolusite (MnO_2), cryptomelane, pyrochroite ($Mn(OH)_2$), an unnamed manganese mineral—probably a hydrous manganese dioxide—identified thus far only by X-ray methods, a trace of another unidentified manganese mineral, quartz, opal, calcite in veinlets cutting the manganese ore, magnetite, and halloysite ($Al_2O_3.2SiO_3.2H_2O$), which is found as a pink filling in fractures. The quartz and opal occur in patches or pockets in the hard siliceous ore. They are generally dark brown because of finely disseminated manganese oxides, but in a few places the opal is pink. The dominant manganese mineral in all the samples studied is pyrolusite. It is light to dark gray and either massive or crystalline. The ore is accompanied by massive jasper, which generally is red but in places is green.

The results of assays for manganese and silica in 10 samples of ore taken by the writers are given in table 15. The average manganese content of these samples was 42 percent, and the silica content 13 percent. Analyses of the ore in two shipments made to the Metals Reserve Co. in February and April 1944 are given in table 16.

The ore is sorted and screened by hand on a cement platform at the mine, in order to separate and discard the more siliceous part.

TABLE 15.—*Partial chemical analyses of manganese and silica in samples of Abundancia (Zacatecas 7) ore*

[Analyses by Crédito Minero y Mercantil, S. A., México, D. F.]

Number of sample	Manganese (percent)	Silica (percent)	Locality of sample and nature of ore
1	47.1	13.4	Pillar east of shaft 4 "nuevo." Hard massive ore. Sample, 2.4 meters thick, but ore continues both above and below.
2	41.1	19.4	Drift west of shaft 4 "viejo." Mostly hard ore, but some soft oxides. Sample, 1.3 meters thick.
3	46.9	14.8	Drift west of "boca mina" 4. Mixture of hard and soft ore. Sample, 1.2 meters thick.
4	35.3	18.6	Northwest corner of pillar north of shaft 41. Soft ore intercalated with clay. Sample, 1.7 meters thick.
5	44.1	12.8	Stope west of shaft 1. Mostly soft crystalline ore, intercalated with some clay. Sample, 1.4 meters thick.
6	38.4	15.8	South wall of stope in mine 1. Mostly soft ore. Sample, 75 centimeters thick.
7	41.4	13.6	Pillar at 9-meter level south of "boca mina" 1. Soft and hard ore intercalated with clay. Sample, 1.6 meters thick.
8	52.0	4.4	Pillar south of shaft 21. Botryoidal psilomelane type of ore containing crystalline bands, which is best type in mine. Sample, 1.8 meters thick.
9	37.3	17.4	Drift east of "boca mina" 1. Soft ore intercalated with clay. Sample, 1.7 meters thick.
10	35.9	23.2	Composite sample of ore stocked on surface, mostly of screened fines and medium sizes.

A series of 30 assays, furnished by Sr. Madero, of the "fines" (less than 18 mesh) stocked at the mine showed a range in manganese content of 32.8 to 42.0 percent, averaging 37.3 percent, and in the content of insoluble matter of 11.6 to 25.2 percent, averaging 19.0 percent.

TABLE 16.—*Partial chemical analyses of Abundancia (Zacatecas 7) ore shipped in February and April 1944*

Mn	SiO_2	Fe	Al_2O_3	Cu	Pb	Zn	P
42.3	15.0	2.4	1.4	0.0	0.0	Tr.	0.13
52.3	7.5	1.5	.9	.2	.0	0.2	.04

The ore deposits probably have been formed by ascending manganese- and silica-bearing solutions, which impregnated and replaced tuffaceous clays. The most favorable channels for these solutions were the bedding planes in the clays.

In May 1944 the chances seemed good that the ore body would extend considerably farther down the dip and perhaps also along the strike. The thickest part of the ore body had been found in the vicinity of shaft 4 "nuevo," where further exploration down the dip was retarded by the lack of a pump of sufficient capacity to extract the water that entered the shaft. Probably not more than half the ore in the explored area had been mined by May 1944, although much of that left is of lower grade and has more silica than that previously shipped. It is possible that further exploration may reveal as much ore as that already known to exist. It cannot be expected, however, that the grade will be higher than 40 or 42 percent of manganese, nor that the silica content will be less than 12 or 15 percent.

SAN FELIPE DE JESÚS DEPOSIT (8)

The San Felipe de Jesús deposit is 16 kilometers south of the Manganita deposit (6) and about 50 kilometers by road from Cañitas, the nearest rail station. It was owned in 1943 by Aureliano de León and was being operated by the Cía. Minera Manganita, which in May of that year employed 25 miners on the property.

The ore is found partly in vertical fissures in tuffs, and partly in nearly horizontal layers that extend outward from these fissures, along the bedding planes in the tuffs. The fissure zones are filled with either (1) braunite(?), (2) braunite(?) and bementite (hydrous manganese silicate), or (3) braunite(?) and silica. In some places where siliceous ore fills the fissures, the proportion of manganese oxides increases with depth. The ore in the flat layers consists of manganese oxides and braunite(?). The main flat ore body, found from 3 to 5 meters below the surface, is 50 meters long, 30 meters wide, and from 30 to 60 centimeters thick, although in some places it attains a thickness of 2 meters. The thickest part of this ore body, however, contains a greater proportion of silica. A similar ore body, called the Carmen, may be found about 150 meters to the southwest, at a depth of 10 meters below the surface.

To May 1943 the San Felipe de Jesús deposit had yielded 1,000 tons of ore containing more than 40 percent of manganese and less than 10 percent of silica. The amount of ore inferred to remain in the San Felipe de Jesús and Carmen deposits is about 10,000 tons containing 40 percent of manganese and 10 percent of silica. If the ore body should be continuous between these two deposits, the reserves might be as great as 30,000 tons. Deposits of this type are so lenticular, however, that no such tonnage should be inferred without additional exploratory work. The association of the flat layers with the vertical fissure zones suggests that perhaps these layers may not extend very far laterally. At any rate, the ore bodies can be explored by means of diamond drills or shallow shafts at relatively small cost, as they lie very close to the surface. The presence of these flat-lying ore bodies within 10 meters of the surface and the large proportion of oxide ore in them combine to make this deposit attractive.

Tenango deposit (*8c*).—The Tenango deposit is 10 kilometers to the northeast of the San Felipe de Jesús deposit (8). It was owned in 1943 by Aureliano de León and was being operated by the Cía. Minera Manganita, which in May of that year employed 20 men on the property.

This deposit is one of seven that occupy mineralized fissures in tuffs, in a belt 600 meters wide. Strong silicification of the rocks around these fissures has caused the area to resist erosion and to stand some 100 meters above the surrounding country. Within the fissures the ore bodies form chimneys that average 50 meters in height and about 1.2 meters in width. Some ore occurs also in horizontal layers that branch off into the tuffs for as much as 6 meters from the fissures. Most of the ore is composed of braunite(?) or braunite(?) mixed with silica, which gives it a glassy or vitreous lustre, but in some of the lateral offshoots it is composed of black calcite and manganese oxides. The ratio of siliceous ore to oxide ore is about 10:1, with the result that the production from these deposits has been low, compared with that from the Manganita (6) and Abundancia (7) deposits in which the proportion of oxides is greater.

To May 1943 the Tenango deposit had yielded some 500 tons of ore. The reserves in this and the two adjoining deposits, the Pirolusita and Tinajita, are estimated to amount to 20,000 tons of ore containing 40 percent of manganese and perhaps 20 percent of silica. Owing to the variable nature of the mineralization in this type of deposit, however, the reserves may be much greater or less than estimated.

NEGRA DEPOSIT (9)

The Negra deposit is 7 kilometers southwest of Fresnillo. It was first worked during World War I, and in 1943 it was owned by Alberto Stefano of Fresnillo and operated by H. Montagne.

The deposit occurs in a zone of silicified rhyolite that forms a low hill 300 meters long, 150 meters wide, and 15 meters high. The rocks in this zone have been strongly impregnated and replaced by by silica and iron, largely in the form of red and yellow jasper. The manganese mineralization is irregular and is found mainly in elongated chimneys that trend northwest. The main ore body is 60 meters long and 30 meters wide, and has been explored by means of two cuts. One of these is 30 meters long, 15 meters wide, and 10 meters deep, and the other is 10 meters long, 15 meters wide, and 10 meters deep. Besides, some 60 meters of underground workings and associated chambers and stopes up to 5 meters in diameter have been opened up.

The ore seems to be composed principally of braunite and silica. In places bementite is common, in part in fairly coarse crystals. Relatively little oxide ore was seen, although the large pockets that were mined in former years were probably rich in oxides. The ore being mined in 1943 seemed to contain about ten parts of siliceous ore to one part of oxide ore, and difficulty was encountered in keeping the silica content low enough to permit marketing of the ore.

Production from the Negra deposit during World War I is said to have been 10,000 tons of ore. In the few months prior to May 1943, when the deposit was visited, some 1,000 tons are said to have been produced. This ore contained 41 percent of manganese, from 12 to 15 percent of silica, and 5 percent of iron. The reserves in the deposit are difficult to estimate because of the variable nature of the mineralization, but they may amount to about 50,000 tons of ore containing 30 percent of manganese and 20 percent of silica.

TINAJA DEPOSIT (11)

The Tinaja deposit lies in a prominent low hill 6 kilometers west of the stations of Palmireto and La Honda on the railroad from San Luis Potosí to Aguascalientes. It was controlled in 1943 by Martín Sutti and Jesús Robledo of San Luis Potosí but was not being operated when the area was visited in May of that year.

The deposit consists of three manganese-bearing chimneys in two northwestward-trending mineralized zones in silicified rhyolitic tuffs. This silicified rock forms an area about 100 meters in diameter, and because of its resistance to erosion rises about 25 meters above the surrounding country. Three cuts have been made in the deposit: the largest, 15 meters in diameter, is on the south side of the hill;

another lies just north of the hill and is 5 meters in diameter; and the third lies 30 meters northeast of the hill and is likewise about 5 meters in diameter.

Some of the ore consists of a dark reddish-brown rock, which is heavy, weathers black, and is said to contain more than 30 percent of manganese. This may be composed largely of bementite. Less than 10 percent of the ore is estimated to consist of manganese oxides. Fine-grained quartz and jasper are abundantly disseminated through the ore, and difficulty will be encountered in keeping the silica content below 15 percent. The better parts of the ore bodies contain about 35 percent of manganese.

No ore had been shipped from the deposit up to May 1943, principally because of the high silica content. The inferred reserves are 5,000 tons of ore containing 35 percent of manganese and 20 percent of silica, but probably less than 100 tons can be expected that contains 40 percent of manganese and less than 15 percent of silica. The ore is too siliceous to be of much value at present.

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TABLE 17.—*Location, ownership, production, reserves, and type of individual manganese deposits in Mexico*

[Latitude and longitude determined from U. S. Army Eighth Corps maps, for the years 1935–37. In column giving date of most recent work: An asterisk (*) shows deposit was active when visited in spring of 1943; a dagger (†) shows deposit was undeveloped; year, 1942, etc., shows year of last work. Reserves in metric tons: AA, more than 125,000; A from 10,000 to 125,000; B, 1,000 to 10,000; C, less than 1,000]

Deposit No.	Name	Location: North latitude	Location: West longitude	Location: Direction and air-line distance from place named (in kilometers)	Distance by road or trail to railroad (in kilometers)	Distance by trail to road (in kilometers)	Owner or operator	Type of deposit; remarks	Date of most recent work	Production to March 31, 1943: Metric tons	Production to March 31, 1943: Percent of manganese	Reserves: Metric tons	Reserves: Percent of manganese	Source of information [1]
	BAJA CALIFORNIA													
1	Cerro del Centinela deposits.	32°38′	115°44′	20 west of Mexicali	20	5?		(?)	(†)	0		C		Antúnez E. (1943, 1944).
2	Zacatosa deposits	32°14′?	116°18′?	48 southeast of Tecate.	48	(?)		Several veins from 30 to 60 centimeters thick.	(†)	0		C		Do.
2a	Socorro mining district.	31°05′?	115°36′?	130 southeast of Ensenada.	220?	(?)		(?)	(†)	0		C		Do.
3	Sierra de Juárez deposits.	32°10′?	115°45′?	50? southwest of Mexicali.	50?	(?)		(?)	(†)	0		C		Do.
4	Lucifer mine	27°22′	112°23′	17 northwest of Santa Rosalía.	10	0	Mahieux y García Quintanilla, S. en N. C.	Replacement deposits in tuffs.	(*)	[2] 12,000	45–50	AA	45–50	32, 41.
4a	Navidad group	27°21′	112°22′	4.5 southeast of the Lucifer mine (4).[3]	6	0	do	do	1944	([4] [2])	45?	B	30	32, 41.
4b	Palmas deposits	27°23′	112°23′	4 north of the Lucifer mine (4).	10	0	do	do	1944	[4] [2] 120	45?	B	30	32, 41.
5	Eureka claim, Isla San Marcos.	27°12′	112°05′	25 southeast of Santa Rosalía.	[5] 3	([6])	M. F. de Lara (1942)	Veinlets, nodules, and irregular masses in fossiliferous sandstones.	1942	80	25	B	25	39.
6	Azteca deposits	26°55′	112°00′	10 north of Mulegé	[5] 5	10	Henry Allen (1940)	Veins of manganese oxides and calcite in volcanic rocks.	1940	0		C	25	39.
7	Gavilán deposits	26°52′	111°48′	20 east of Mulegé	[5] 0	0	Cía. Mexicana de Manganeso, S. A.	Numerous veinlets and stringers in basaltic rocks.	(*)	10,000?	50	A		22, 32, 41.
7a	Guadalupe deposits	26°49′	111°49′	12 southwest of the Gavilán deposits (7).	[5] 1	3.5		Veins of manganese oxides with gypsum, calcite, iron oxides, chalcedony, and quartz, in basaltic rocks.	1918?	0?		C?	20	Halse (1893), Wallace (1911c).

See footnotes at end of table.

TABLE 17.—*Location, ownership, production, reserves, and type of individual manganese deposits in Mexico*—Continued

Deposit No.	Name	Location: North latitude	Location: West longitude	Location: Direction and air-line distance from place named (in kilometers)	Distance by road or trail to railroad (in kilometers)	Distance by trail to road (in kilometers)	Owner or operator	Type of deposit; remarks	Date of most recent work	Production to March 31, 1943: Metric tons	Production to March 31, 1943: Percent of manganese	Reserves: Metric tons	Reserves: Percent of manganese	Source of information [1]
	BAJA CALIFORNIA—Continued													
7b	Trinidad deposit	26°49′	111°46′	7 southeast of the Gavilán deposits (7).	[5] 0.5	7	Henry Allen (1940)	Veins and nodules of manganese oxides with much iron oxides, sparsely distributed in sandstones and conglomerates. Three small cuts in deposit.	1940	0?	-----	B?	20?	Antúnez E. (1943, 1944), Wallace (1911a, b, c; 1916), Halse (1893).
7c	Santa Rosa deposit	26°45′	111°40′	18 southeast of the Gavilán deposits (7).	[5] 0	18		Joints lined with manganese oxides.	(†)	0	-----	C?	20?	Wallace (1911 a, b, c; 1916), Halse (1893).
8	Santa Teresa deposit	26°41′	111°35′	30 southeast of the Gavilán deposits (7).	[5] 0	15		Veinlets from 1 millimeter to 15 centimeters thick, in hard basalt.	(†)	0?	-----	C?	20?	Antúnez E. (1943, 1944).
9	Santa Isabel (San Nicolás) deposit.	26°29′	111°33′	57 northwest of Loreto.	[5] 7	15		Veins in reddish volcanic conglomerate, accompanied by veinlets of calcite and orange opal.	1918?	300?	45?	B	45?	39.
9a	San Juanico deposit	26°27′	111°32′	53 northwest of Loreto.	[5] 12	14		Veinlets and irregular pockets in fossiliferous sandy limestones.	(†)	0	-----	C	20?	39.
9b	Punta Pílpito deposits.	26°31′	111°27′	58 north of Loreto	[5] 0	21		Veinlets in volcanic rocks?	(†)	0	-----	C	-----	Antúnez E. (1943, 1944).
10	Punta Mangles deposit.	26°18′	111°24′	31 north of Loreto	[5] 0	11		do	(†)	0	-----	C	-----	Do.
11	Isla Carmen deposit	26°03′	111°06′	26 east of Loreto	[5] 0	(6)		do	(†)	0	-----	C?	-----	Do.
12	Isla Santa Margarita deposit.	20°20′?	111°45′?	160 west of La Paz	[5] 0	(6)		Veinlets in volcanic rocks?	(†)	0	-----	C?	-----	Biddle (1906).
13	San Antonio deposit	23°49′	110°02′	46 southeast of La Paz.	[5] 26	0		Gangue in silver, gold, and lead ores.	(†)	0	-----	C?	-----	2, 14.
13a	Triunfo deposit	23°49′	110°06′	43 southeast of La Paz.	[5] 31	0		do	(†)	0	-----	C?	-----	2, 14.

Chihuahua

1	Borregos area	31°10′	107°21′	15 southeast of Guzmán.	31	0	Tennessee Co.	Black calcite in fissures in rhyolite.	(*)	6,000	42?	A	30	35.
1a	Consolidada deposit	31°10′	107°21′	In the Borregos area (1).	31	0	do.	do.	(*)	(4)		(4)		35.
1b	Verdún deposit	31°10′	107°21′	North of the Consolidada deposit (1a).	31	1	Sr. Hemly	do.	(†)	0		B	30	9.
1c	Don Toribio deposit	31°10′	107°21′	West of the Verdún deposit (1b).	31	1	Charles Armijo	do.	(†)	0		(4)		9.
1d	Prieta deposit	31°10′	107°21′	South of the Don Toribio deposit (1c).	31	0	Sra. Gertrudis González de Armijo.	do.	(†)	0		(4)		9.
1e	San Carlos deposit	31°10′	107°21′	South of the Consolidada deposit (1a).	31	0	Sr. Hemly	do.	(†)	0		(4)		9.
1f	Madrid deposits	30°10′	107°21′	do.	31	0	Marcelus Madrid	do.	(†)	0		(4)		9.
1g	Santa María deposit	31°11′	107°21′	2 north of the Consolidada deposit (1a).	30	0	N. L. Casner	do.	(*)	350	42?	B	30	35.
2	Ascensión deposits	30°55′	107°56′	21 south of Ascensión.	40	5?		Fissure deposits in rhyolite.	(†)	0		C	30	9.
3	Sabinal deposits	30°56′	107°35′	10 west of Sabinal station.	12	3	C. Romero	do.	(†)	0		C	30	9.
3a	Salazar 2 deposit	31°3′	107°38′	18 northwest of Sabinal station.	20	5?	William Salazar	do.	(†)	0		C	30	9.
4	Domínguez deposit	30°57′	107°23′	11 east of Sabinal station.	11	3?	Sr. Domínguez	do.	(†)	0		C	30	9.
4a	Salazar 1 deposit	31°4′	107°22′	17 northeast of Sabinal station, south of the Borregos area (1).	20	5?	William Salazar	do.	(†)	0		C	30	9.
4b	Fresnal deposit (Salazar 1).	31°4′	107°22′	17 northeast of Sabinal station.	20	5?	William Salazar?	do.	(†)	0		(4)		9.
5	Ranchería deposit	31°3′	106°21′	17 northeast of Ranchería station.	20	5?		do.	(†)	0		C	30	9.
6	Casas de Janos deposit.	30°45′	108°22′	50 southwest of Ascensión.	60	5?	Alejandro Chávez	Vein 2 meters wide in volcanic rocks. Freight to railroad 25 pesos per ton.	(†)	0		B	30	9.
7	Cuatro Amigos deposit.	30°36′	107°28′	20 southeast of San Pedro station.	20	0	Louis B. Goldbaum	2 veins of black calcite, from 60 to 100 centimeters wide and 100 meters long, in volcanic rocks.	(*)	15		B	25	9, 33.

See footnotes at end of table.

TABLE 17—*Location, ownership, production, reserves, and type of individual manganese deposits in Mexico*—Continued

Deposit No.	Name	Location: North latitude	Location: West longitude	Location: Direction and air-line distance from place named (in kilometers)	Distance by road or trail to railroad (in kilometers)	Distance by trail to road (in kilometers)	Owner or operator	Type of deposit; remarks	Date of most recent work	Production to March 31, 1943: Metric tons	Production to March 31, 1943: Percent of manganese	Reserves: Metric tons	Reserves: Percent of manganese	Source of information [1]
							Chihuahua—Continued							
8	Refugio deposit	30°37′	106°6′	40 east of Ahumada station.	45	3?	Loui B. Goldbaum	Fissure deposits in volcanic rocks.	1942	0	-----	B	30	10.
9	Casas Grandes area	30°23′	107°59′	6 southwest of Nuevo Casas Grandes.	4	0	Julian Aguilar	Black calcite veins in rhyolite.	(*)	500	42	A	30	35.
9a	Don Cuco deposit	30°23′	107°59′	In the Casas Grandes area (9).	4	0	do	do	(*)	(4)	-----	(4)	-----	35.
9b	Aguilar deposit	30°22′	107°59′	1 douth of the Don Cuco deposit (9a).	4	0	do	2 veins of black calcite from 30 to 60 centimeters wide and 50 meters long, in rhyolite.	(*)	(4)	-----	C	30	35.
9c	Orizabeña deposit	30°21′	107°59′	3 south of the Don Cuco deposit (9a).	4	0	Juian Hernández	do	(*)	50	41	C	20	35.
9d	Azatlán veins	30°21′	107°59′	Northwest of the Orizabeña deposit (9c).	4	0	do	do	(*)	0	-----	C	25	35.
9e	Tapatia deposit	30°21′	107°59′	West of the Azatlán veins (9d).	4	0	do	do	(*)	0	-----	C	15	35.
10	Apache deposits	30°20′	107°32′	40 east of Casas Grandes.	40	0	Alfredo González, and others.	Fissure deposits in volcanic rocks?	(*)	150	40	C	30	9.
11	Ojo Caliente deposit	30°20′	106°26′	12 southeast of Ojo Caliente.	13	1?		Fissure deposit	(†)	0	-----	C?	-----	9.
12	Wilkie deposit	30°9′	108°13′	60 south-southwest of Casas Grandes.	30?	5?	Leighton A. Wilkie	do	(†)	0	-----	(?)	-----	25.
13	Ascensión deposit	30°8′	107°38′	Within 5 of Galeana	40	5?	A. Madero	Veins of manganese and iron oxides?	(†)	0	-----	C?	20	15.
14	Carrizo deposit	30°13′	106°40′	23 west of Moctezuma.	25	8?		Veins of manganese and iron oxides.	(†)	0	-----	C	25?	9.
15	Agua Nueva deposit	29°41′	106°12′?	15? east of Mocho station.	15?	5?	Carlos Sisniega	Veins of manganese and iron oxides?	1942	0	-----	C	20	28.
16	Encinillas deposit	29°15′	106°18′	5 northwest of Encinillas station.	5	3?		do	(†)	0	-----	C?	25	8.

17	Hormigas deposit	29°18′	105°48′	23 northwest of Hormigas station.	30	10?		Fissure deposit	(†)	0		C?	25	9.
18	Sóstenes deposit	29°15′	105°17′	7 north of Sóstenes	10	5?		Fissure deposit	(†)	0		C?	25	10, 3.
19	Chilicote deposit	29°2′	104°49′	5 north? of Chilicote	5?	5?	Abraham Luján Z.	Fissure deposit in volcanic rocks?	(†)	0		C?	25	16.
20	Alkadeff deposit	28°36′	107°40′	15 southwest of Santo Tomás.	15	5?	J. Alkadeff	do	(†)	0		C?	25	1.
21	Adela deposits	28°41′	106°40′	21 northwest of San Andrés.	21	3?		(?)	(†)	0		C?	25?	8.
22	Virgen and Providencia deposits.	28°47′	106°21′	30 northwest of Chihuahua City.	30	5?	Dr. Erco García	Fissure deposits in volcanic rocks?	(†)	0		B?	30?	13.
23	Santa Rosa and Coronel deposits.	28°43′	106°4′	10 northeast of Chihuahua City.	10	5?		(?)	(†)	0		C?	25	8, 10.
24	Cusihuiriáchic deposit.	28°17′	106°50′	5 north of Cusihuiriáchic.	5	3?		Black calcite in volcanic rocks?	(†)	0		C?	25	8, 2.
25	San Isidro deposit	28°21′	106°7′	12 southeast of Las Palomas.	8	3	Dr. Erco García	Fissure deposit in volcanic rocks?	(†)	0		C?	25	33, 13.
26	Magistral mine area	28°8′	106°17′	26? south of Santa Isabel, near Magistral mine.	26	0?	Jack Ryan	As gangue in gold and silver veins.	(†)	0		B?	30	10.
27	Zacate mine	28°10′	106°8′	26 south of Las Palomas.	40	0	Leo Naudín	Fissure deposit in rhyolite.	(*)	9,000	35?	A	30	35.
27a	Chino deposits	28°8′	106°8′	29 south of Las Palomas.	43	0	do	Black calcite veins in rhyolite.	1940	3,000	40?	A	30	35.
28	Savanarola mine	28°4′	105°46′	33 southwest of Meoqui.	33	5?	Jesus Prieto Becera	(?)	(†)	0		B?	25	10.
29	Organos deposits	28°17′	104°55′	50 northeast of Saucillo.	60	2	Cía. Explotadora de Minerales.	do	(*)	300	41	A	30	32.
29a	San Miguel deposits	28°17′	104°55′	Same as the Organos deposits (29)?.	60	2	do	do	(*)	(4)		(4)		32.
29b	Antonio Farias deposits.	28°17′	104°55′	do	60	2	do	Black calcite veins in rhyolite.	(*)	(4)		(4)		32.
29c	Socorro deposit	28°16′	105°2′	10 west of the Organos deposits (29).	60	1	do	Fissure deposit in volcanic rocks?	(†)	0		C	25	32.
29d	Escondida deposit	28°16′	105°1′	East of the Socorro deposit (29c).	60	0	do	do	(*)	100		B	25	32.
30	Minas Nuevas deposit.	27°8′	105°41′	20 north of Parral	20	5?		(?)	(†)	0		C?	25?	2.
31	Talamantes manganese district.	26°53′	105°28′	20 east of Parral	15	0	Various	Veins and replacement of matrix of fault breccia, in volcanic rocks.	(†)	[7]45,000		AA	25	32, 34, 40.
32	Matamoros deposits	26°44′	105°36′	3 south of Villa Matamoros.	8	0	Manuel Duarte, and others.	Black calcite veins and pockets in rhyolite.	1942	250	35?	B	25	32.
32a	Santa Bárbara deposits.	26°44′	105°36′	Same as the Matamoros deposits (32).	8	0	do	do	1942	(4)		(4)		32.
32b	Tres Estrellas deposit.	26°44′	105°36′	In the Matamoros area (32).	8	0	do	do	1942	(4)		(4)		32.
32c	Luz deposit	26°44′	105°36′	do	8	0	do	do	1942	(4)		(4)		32.
32d	Cruz deposit	26°44′	105°36′	do	8	0	do	do	1942	(4)		(4)		32.
32e	Capitán deposit	26°44′	105°36′	do	8	0	do	do	1942	(4)		(4)		32.
32f	Vesta deposit	26°44′	105°36′	do	8	0	do	do	1942	(4)		(4)		32.

See footnotes at end of table.

TABLE 17.—*Location, ownership, production, reserves, and type of individual manganese deposits in Mexico*—Continued

Deposit No.	Name	Location: North latitude	Location: West longitude	Location: Direction and air-line distance from place named (in kilometers)	Distance by road or trail to railroad (in kilometers)	Distance by trail to road (in kilometers)	Owner or operator	Type of deposit; remarks	Date of most recent work	Production to March 31, 1943: Metric tons	Production to March 31, 1943: Percent of manganese	Reserves: Metric tons	Reserves: Percent of manganese	Source of information [1]
							Chihuahua—Continued							
32g	Nuevo Vesuvio deposit.	26°45′	105°31′?	27 southeast of Parral.	8?	0	Román S. Concha	Veins of antimony ore with manganese oxides, in siliceous and calcareous shales.	(*)	0	-----	[8] C	30	38.
33	Rosario deposits	26°31′	105°30′	15 east of Rosario	15	10?		Black calcite veins in rhyolite?	(†)	0	-----	C?	-----	8.
33a	Valdarama deposits	26°31′	105°30′	Same as the Rosario deposits (33)?	15	10?	Agapita Valdarama	do	(†)	0	-----	(4)	-----	20.
34	San Julián deposits	26°4′	106°37′	130 southwest of Parral.	100	25?	Fernández brothers	Said to contain high-grade ore. Shipping cost to railroad about 70 pesos per ton.	(†)	0	-----	C?	-----	11.
							Coahuila							
1	Gómez deposit	29°13′	101°4′	15 southwest of Villa Acuña.	15	10?	Gudelio Garza Gómez.	(?)	(†)	0	-----	C?	-----	10.
2	Lucero deposit	27°43′	101°28′	13 west of La Esperanza.	15	2	Abraham Jiménez Cárdenas.	Black calcite and braunite replacement deposit in limestone.	1942	40	30	C	25	32.
3	Baluarte deposit	27°20′	101°11′	13 northeast of Las Hermansa.	13	1	Sr Garza Castro	Replacement zone in massive limestone.	1942	0	-----	C	3	32.
3a	Garza Castro deposit	27°20′	101°11′	1 north of the Baluarte deposit (3).	13	1	do	Zone of manganese oxides in breccia. One cut 6 meters long and 3 meters deep.	(*)	0	-----	C	15	32
3b	Hermanas deposit	27°19′	101°11′	2 south of the Baluarte deposit (3).	11	0	do	Nodules and boulders of limestone replaced by manganese oxides.	(†)	0	-----	C	20	32.

4	Sierra Mojada deposit.	27°18′	103°45′	5 south? of Sierra Mojada.	5?	5?	Cía Fundidora de Fierro y Acero de Monterrey, S. A.	Fissure deposit in volcanic rocks?	(†)	0	-----	C?	-----	2.
5	Navarette Torres deposit.	26°52′	101°30′	10 west of Monclova.	10	3?	Enrique Navarrete Torres.	Veins with rhodochrosite?	(†)	0	-----	C?	-----	10.
6	Candela deposits	26°48′	100°55′	26 west of Candela	40	1	Various	Veins and replacement deposits along igneous contacts with limestone. Contain calcite, fluorite, barite, galena, and some alabandite.	(*)	2,300	45	A	40	32.
6a	Cerro Colorado deposits—Candela deposts (6).	26°48′	100°55′	26 west of Candela	40	1	do	Similar to Candela deposits (6).	(*)	([4])	-----	([4])	-----	32.
6b	Milagro deposit	26°48′	100°55′	East side of Candela area (6).	40	1	Remigio Martínez, and others.	do	(*)	([4])	-----	([4])	-----	32.
6c	Anáhuac deposit	26°48′	100°56′	West side of Candela area (6).	40	1	Leopoldo Villareal, Jr.	do	(†)	([4])	-----	([4])	-----	32.
6d	Anhelo deposit	26°48′	100°56′	do	40	1	do	do	(†)	([4])	-----	([4])	-----	32.
6e	Canales deposit	26°48′	100°56′	do	40	1	do	do	(†)	([4])	-----	([4])	-----	32.
6f	Exito deposit	26°48′	100°56′	do	40	1	do	do	(†)	([4])	-----	([4])	-----	32.
6g	Resolución deposit	26°48′	100°56′	do	40	1	do	do	(†)	([4])	-----	([4])	-----	32.
6h	Titán deposit	26°48′	100°56′	do	40	1	do	do	(†)	([4])	-----	([4])	-----	32.
7	Eureka deposits	25°50′	101°29′	27 north of Hipólito	27	0	General Gabriel R. Cervera.	Chimneylike replacements in limestone. Probably braunite.	1943	250	40	C	35	33, 36.
8	Victoria deposit	24°52′	101°35′	5 east of San Pedro Ocampo.	5	2	Leopoldo Villareal, Jr.	Chimneylike replacement, in limestone. Consists principally of braunite.	(†)	0	-----	C	20	33, 36.
	Durango													
1	Guanaceví deposit	25°56′	105°58′	70 northwest of Tepehuanes.	80	3?		Fissure deposit in rhyolite? Possibly gangue in lead, silver, or antimony ore?	(†)	0	-----	C?	-----	2.
2	Dinamita deposits	25°40′	103°40′	30 northwest of Torreon, Coahuila.	15	0	Various	Replacement deposits in massive limestone, around granite stock. Black calcite and manganese oxides.	(*)	[9]11,875	-----	[9]A	38	32, 34.
2a	Cerro Colorado deposits—Dinamita deposits (2).	25°40′	103°40′	do	15	0	do	Similar to the Dinamita deposits (2).	(*)	([4])	-----	([4])	-----	32, 34.
2b	Sarnosa deposit	25°40′	103°40′	In the Dinamita area (2).	15	2	Arturo Villar	do	(*)	10,000	42	A	45	32.

See footnotes at end of table.

TABLE 17.—*Location, ownership, production, reserves, and type of individual manganese deposits in Mexico*—Continued

Deposit No.	Name	Location: North latitude	Location: West longitude	Location: Direction and air-line distance from place named (in kilometers)	Distance by road or trail to railroad (in kilometers)	Distance by trail to road (in kilometers)	Owner or operator	Type of deposit; remarks	Date of most recent work	Production to March 31, 1943: Metric tons	Production to March 31, 1943: Percent of manganese	Reserves: Metric tons	Reserves: Percent of manganese	Source of information [1]
							Durango—Continued							
2c	Santiana mine	25°40′	103°39′	1 east of the Sarnosa deposit (2b).	15	1	Sr. Santiana	Similar to the Dinamita deposits (2).	(*)	200	42	B	38	33.
2d	González deposit	25°40′	103°39′	do	15	1	Antonio González	do	(†)	0		C		6.
2e	Nena deposit	25°39′	103°39′	2 south of the Sarnosa deposit (2b).	18	1	Theodore Symons	do	(*)	[10] 100	38	B	38	34.
2f	Zurrita deposit—Nena deposit (2e).	25°39′	103°39′	do	18	1	do	do	(*)	(4)		(4)		34.
2g	Luz deposit	25°39′	103°39′	1 west of the Nena deposit (2e).	18	2	Ernesto Madero and others.	do	(*)	[10] 1,500	38	A	38	34.
2h	García deposit—Luz deposit (2g).	25°39′	103°39′	do	18	2	do	do	(*)	(4)		(4)		34.
2i	Merino deposits	25°39′	103°39′	1 south of the Luz deposit (2g).	18	1	Sr. Merino	Similar to the Dinamita deposits (2). East-trending vein 15 meters long and 1 meter wide; another smaller vein nearby.	(*)	75	38	C	38	34.
2j	Madero deposits	25°39′	103°39′	2 south of the Luz deposit (2g).	18	0	Erneso Madero	Similar to the Dinamita deposits (2). East-trending vein 3 meters long and 60 centimeters wide; another smaller vein nearby.	(†)	0		C	30	34.
2k	Márquez deposit	25°40′	103°40′	In the Dinamita area (2).	15	3?	José Márquez	(?)	(†)	0		C?		18.
2l	Cerro Blanco deposit.	25°27′	103°31′	10 south of Lerdo	10?	5?		(?)	(†)	0		C?		8, 33.
2m	Negra deposit	25°40′	103°45′	9 west of the Sarnosa deposit (2b).	30	0	Sra. Julia Pamones de Cueto.	Similar to the Dinamita deposits (2).	(*)	0		C	38	32.
2n	Providencia deposit	25°40′	103°45′	Just east of the Negra deposit (2m).	30	0	do	do	(*)	0		C	38	32.
2o	Mapimí deposit—one of Dinamita deposits (2).	25°40′	103°45′	30 northwest of Torreón, Coahuila.	30	0	do	do	(*)	0		(4)		2.
2p	Fama deposit	25°42′	103°47′	5 northwest of the Negra deposit (2m)	35	3?	do	do	(†)	0		C	38	33, 24.
2q	Chiripa deposit	25°42′	103°47′	do	35	3?	do	do	(†)	0		C	38	33, 24.

r	Ostos deposits	25°39′	103°43′	5 southeast of the Negra deposit (2m).	25	3?	Dr. Enrique Ostos	do	(†)	0		B	38	33, 23.
3	Picacho de La Candela deposits.	25°25′	105°28′	30 east of Tepehuanes.	35	35	Various	Replacement of tuffs, fissure fillings, and coatings of manganese oxides on breccia fragments.	1942	[9] 200	38	[9] A	30	35.
3a	Progreso claim	25°25′	105°28′	North end of Picacho area (3).	35	35	Cía. Minera Central	Replacement of tuff?	(†)	0		C		35.
3b	Esperanza deposit	25°25′	105°28′	1 west of the Progreso claim (3a).	35	35	do	Drusy coatings on fragments of cilicified tuff.	(†)	0		C	45	35.
3c	Cía. Mineral Central deposit.	25°25′	105°27′	2 east of the Progreso claim (3a).	35	35	do	Manganese oxides in breccia along a fissure.	1942	25	38	B	15	35.
3d	President Roosevelt deposit.	25°25′	105°28′	Just south of the Progreso claim (3a).	35	35	do	Replacement of tuff	(†)	0		C		35.
3e	Guadalupe deposit	25°24′	105°28′	Just south of the President Roosevelt deposit (3d).	35	35	Darrell M. Wonn	do	1942	175	38	A	30	35.
3f	Purísima deposit	25°24′	105°28′	Just south of the Guadalupe deposit (3e).	35	35	Cía. MineraCentral	Replacement of tuff. Crops out in area 15 meters long and from 2 to 5 meters wide.	(†)	0		C	20	35.
3g	Wonn No. 2 deposit	25°24′	105°28′	Just south of the Purísima deposit (3f).	35	35	Darrell M. Wonn	Replacement of tuff. Crops out in area 15 meters long and 3 meters wide.	(†)	0		C		35.
3h	Presidio deposit	25°23′	105°28′	Just south of the Wonn No. 2 deposit (3g).	35	35	Cía. Minera Central	Probably replacement of tuff.	(†)	0		C		35.
3i	General McArthur deposit.	25°23′	105°28′	Just southwest of the Presidio deposit (3h).	35	35	do	Replacement of tuff	(†)	0		C		33,12.
4	Tepehuanes deposits	25°17′	105°44′	7 south of Tepehuanes.	10	10?	Various	Fissure deposits in rhyolite?	(†)	0		B		33,12.
5	Patos deposits	25°07′	105°0′	25 north of Patos	25	0	General Mario Arieta.	Black calcite in fissures in fanglomerate.	(*)	100		B		32, 12.
5a	Arieta deposits—Patos deposits (5).	25°07′	105°0′	do	25	0	do	do	(*)	(4)		(4)		33, 12.
6	Villegas deposits	24°53′	105°7′	10 west of Patos	10	10?	Juan Villegas	Fissure deposits in volcanic rocks?	(†)	0		B		33, 12.
7	Cuencamé deposit	24°48′	103°42′	10 south of Cuencamé.	10	5?		(?)	(†)	0		B?		8, 2.
8	Santiago deposit	24°33′	103°43′	35 south of Cuencamé.	25	5?	Juan Pérez	(?)	1926	1, 500		B		Rangel (1911), Santillán (1936).
8a	Cerro de Santiago deposit—Santiago deposit (8).	24°33′	103°43′	do	25	5?	do	(?)	1926	(4)		(4)		Santillán (1936), Rangel (1911).
9	Purísima deposit	24°15′	103°45′	70 south of Cuencamé.	35	2	do	Black calcite deposit in fissures?	(†)	0		C		Santillán (1936).
10	Poanas deposit	23°55′	104°6′	3 northeast of Poanas.	3	3?		(?)	(†)	0		(?)		8.

See footnotes at end of table.

TABLE 17.—*Location, ownership, production, reserves, and type of individual manganese deposits in Mexico*—Continued

Deposit No.	Name	Location: North latitude	Location: West longitude	Location: Direction and air-line distance from place named (in kilometers)	Distance by road or trail to railroad (in kilometers)	Distance by trail to road (in kilometers)	Owner or operator	Type of deposit; remarks	Date of most recent work	Production to March 31, 1943: Metric tons	Production to March 31, 1943: Percent of manganese	Reserves: Metric tons	Reserves: Percent of manganese	Source of information [1]
	Guanajuato													
1	Atarjea deposit	21°17′	99°48′	100 northeast of Querétaro, Quer.	100	20?		(?)	(†)	0		(?)		8.
2	Victoria mine	21°16′	101°43′	14 north of León	20	0	Crédito Minero	Oxidized lenses of manganese silicate in slaty shales.	(*)	300	42	B	35	35.
2a	San José de Otates deposit—Victoria mine (1)?	21°16′	101°43′	do	20	0	do	do	(*)	(4)		(4)		35.
2b	Asunción deposit—Victoria mine (2)?	21°16′	101°43′	do	20	0	do	do	(*)	(4)		(4)		35.
2c	Negra deposit	21°16′	101°43′	2? from Victoria mine (2).	20	2?	Guillermo Arguilles	do	(†)	0		C		33, 10.
2d	Fortuna deposit	21°16′	101°43′	do	20	2?	Guillermo *Arguilles*	do	(†)	0		C		33, 10.
3	Protectora deposit	21°11′	101°34′	14 east of León	13	5	Justo *Pedroza*	do	1942	200	38	[11] B	35	35.
3a	Guanajuato deposit—Protectora deposit (3)?	21°11′	101°34′	Near León	13?	5?	H. C. Baldwin	Psilomelane and rhodochrosite.	1918	(4)		(4)		15.
3b	Cabras deposit—Protectora deposit (3)?	21°11′	101°34′	14 east of León	13	5		(?)	1942	(4)		(4)		8.
	Guerrero													
1	San José deposit	18°23′	100°15′	15 north of Arcelia	160	3?	Cía. Minera La Guadalupana.	Lenses in silicified fracture zones in tuffs.	(†)	0		C		33, 37.
1a	Peyotlán deposit	18°23′	100°13′	3 east of the San José deposit (1).	160	3?	do	do	(†)	0		C		33, 37.
1b	Palos Altos deposit	18°23′	100°11′	3 east of the Peyotlán deposit (1a).	160	3?	do	do	(†)	0		C		33, 37.

2	Tierra Blanca deposit	18°25′	99°52′	4 north of Teloloapan	50	4	Manuel de la Puente	Fillings in brecciated limestones and andesites. Three small pits in mineralized rock.	(†)	0	-----	C	15	38.
2a	Concepción deposit	18°25′	99°53′	1 south of the Tierra Blanca deposit (2).	50	3	do	Fissure deposits in andesites. Pit 6 meters long, 3 meters wide, and 3 meters deep. Some rhodonite present.	(†)	0	-----	C	15	38.
2b	Chapas deposit	18°20′	99°51′	6 southeast of Teloloapan.	40	3?	Cía. Minera La Guadalupana.	(?)	(†)	0	-----	C	-----	33, 37.
3	Iguala deposit	18°21′	99°37′	3 southwest of Iguala.	3	2?		(?)	(†)	0	-----	D	-----	8.
4	Buenavista region	18°29′	99°29′	15 northeast of Iguala.	10	10	Comercio General	Chimneylike deposits that replace limestone breccia.	(*)	[9]400	42	B	40	32.
4a	Lucha deposit	18°29′	99°29′	North end of the Buenavista region (4).	11	11	do	Replacement of limestone breccia. About 1 ton of mammilary oxide ore produced up to June 1943.	(†)	0	-----	C	-----	33, 5.
4b	Avión deposit—Lucha deposit (4a).	18°29′	99°29′	do	11	11	Comercio General ?	Similar to 4. Very small. Hand-picked ore assayed 44 percent of manganese.	(†)	0	-----	([4])	-----	33, 10.
4c	Jacobo deposit	18°29′	99°29′	1 south of the Lucha deposit (4a).	11	11	Comercio General	Similar to 4. Very small.	(†)	0	-----	C	-----	33, 10.
4d	Dos Lupes deposit	18°28′	99°27′	1 southwest of the Jacobo deposit (4c).	10	10	do	Similar to 4. Produced about 5 tons of ore up to June 1943.	(*)	5	-----	C	38	33.
4e	Gabriela deposit	18°28′	99°27′	Near the Dos Lupes deposit (4d).	10	10	do	Similar to 4. Mineralized zone said to be 5 meters wide. In June 1943 the dumps contained 200 tons with from 16 to 37 percent of manganese.	(*)	([4])	-----	([4])	-----	33, 10.
4f	Vidal deposit	18°28′	99°27′	Just east of the Dos Lupes deposit (4d).	10	10	do	Similar to 4. Very small.	(*)	0	-----	C	25	5.
4g	India deposit	18°28′	99°27′	Just southeast of the Dos Lupes deposit (4d).	10	10	H. W. Fowler and others.	do	(†)	0	-----	C	25	32.
4h	Carmen deposit	18°26′	99°28′	3 southeast of the India deposit (4g).	8	8	Comercio General	Similar to 4	1942	200?	-----	C	40	32.
4i	Urquiri deposit	18°29′	99°26′	4 east of the Lucha deposit (4a).	11	11	do	Similar to 4. Very small.	(†)	0	-----	C	-----	33, 5.
4j	Caballo deposit	18°29′	99°26′	Just southeast of the Urquiri deposit (4i).	11	11	do	do	(†)	0	-----	C	-----	33, 5.

See footnotes at end of table.

TABLE 17—*Location, ownership, production, reserves, and type of individual manganese deposits in Mexico*—Continued

Deposit No.	Name	Location			Distance by road or trail to railroad (in kilometers)	Distance by trail to road (in kilometers)	Owner or operator	Type of deposit; remarks	Date of most recent work	Production to March 31, 1943		Reserves		Source of information [1]
		North latitude	West longitude	Direction and air-line distance from place named (in kilometers)						Metric tons	Percent of manganese	Metric tons	Percent of manganese	
							Guerrero—Continued							
4k	Tocayas deposit	18°29′	99°26′	Just east of the Caballo deposit (4j).	10	10	do	Similar to 4. Very small.	(†)	0		C		33, 5.
4l	Porfirio deposit	18°28′	99°26′	1.5 south of the Tocayas deposit (4k).	10	10	do	1 cut 8 meters in diameter and 5 meters deep, nearly mined out.	1942	10?	40	C	30	32.
4m	Cabrillo deposit	18°28′	99°26′	1 southeast of the Porfirio deposit (4l).	9	9	do	Similar to 4. 2 cuts, of which larger is 7 by 5 by 3 meters.	1942	10?	40	C	30	32.
4n	Unión deposit	18°27′	99°26′	Just southeast of the Cabrillo deposit (4m).	9	9	do	Similar to 4	(*)	100?	40	C	30	32.
4o	Negra deposit	18°27′	99°26′	Just southeast of the Unión deposit (4n).	1	1	do	Similar to 4. Mineralized zone 5 meters long and 1.5 meters wide, in which one cut had been made.	(*)	25?	40	C	30	32.
4p	María deposits	18°25′	99°26′	5 south of the Negra deposit (4o).	1	1	do	Similar to 4	1942	50?	40	B	15	32.
4q	Southwest deposits	18°25′	99°26′	2 west of Buenavista station.	0	0		Similar to 4. Several fissure zones containing ore with 10 percent of manganese.	(†)	0		B	10?	32.
4r	Joya deposits	18°31′	99°23′	12 northeast of Buenavista station.	6	6?	Mario Jiménez Galindo.	Veinlets of manganese oxides in rhyolite.	(†)	0		C		5.
5	Consuelo deposits	17°20′	99°32′	25 south of Chilpancingo.	160	7	Productos Mineros Mexicanos.	Chimneylike deposits that replace limestone.	(*)	0		[12] B	30	32.
5a	Lucky Nina deposit	17°20′	99°32′	Just west of the Consuelo deposits (5).	160	7	do	Similar to 5	(*)	0		[12] B	30	32.

Hidalgo														
1	Jacala deposits	21°0′	99°9′	6 east of Jacala	175	0	Sr. Bourneman	Replacement of limestone, in chimneys.	1942	40	30	B	20	35.
2	Pachuca region	20°8′	98°42′	In the Pachuca mining district.	0	0		Gangue in silver-lead-gold veins. Richest ore contains 30 percent of manganese. Rhodonite at depth.	(†)	0		[11] B	20?	Aguilera (1902).
Jalisco														
1	Hostotipaquilla deposit.	21°7′	104°3′	Near Hostotipaquilla.	20	0		Gangue in silver-lead-gold ores? Silicate or carbonate at depth.	(†)	0		[13] D	20	2.
1a	Favor deposit—Hostotipaquilla deposit (1).	21°7′	104°3′	do	20	0		Same as 1	(†)			D		Villafaña (1916).
2	Mezcala deposits	20°57′	102°43′	15 north of Tepatitlán.	15	0	Adelberto Taylor	Fissure depoists in rhyolite.	1942	0		B?	25?	33, 6.
2a	Amparo deposit	20°57′	102°43′	In the Mezcala area (2).	15	(?)	do	(?)	1942?	0		(4)		33, 6.
2b	Bertha deposit	20°57′	102°43′	do	15	(?)	do	(?)	1942?	0		(4)		33, 6.
2c	Chiripa deposit	20°57′	102°43′	do	15	(?)	do	(?)	1942?	0		(4)		33, 6.
2d	Colomas deposit	20°57′	102°43′	do	15	(?)	do	(?)	1942?	0		(4)		33, 6.
2e	Concepción deposit	20°57′	102°43′	do	15	(?)	do	(?)	1942?	0		(4)		33, 6.
2f	Elba deposit	20°57′	102°43′	do	15	(?)	do	(?)	1942?	0		(4)		33, 6.
2g	Madgalena deposit	20°57′	102°43′	do	15	(?)	do	(?)	1942?	0		(4)		33, 6.
2h	Murallas deposit	20°57′	102°43′	do	15	(?)	do	(?)	1942?	0		(4)		33, 6.
2i	Olga deposit	20°57′	102°43′	do	15	(?)	do	(?)	1942?	0		(4)		33, 6.
3	Progreso deposit	21°18′	101°43′	21 north of León, Guanojuato.	40	1	J. J. Falomir	Lenses of manganese oxides in slaty shales. Rhodonite and rhodochrosite at depth.	1942	100	35?	C	25	35.
3a	Comanja deposit—Progreso deposit (3)?.	21°18′	101°43′	do	40	1	do	Same as 3	1942	(4)		(4)		8.
Mexico														
1	El Oro deposit	19°45′	100°8′	3 south of El Oro	3	3?		Gangue in silver-lead-gold ores?	(†)	0		C		8.
1a	Tajimarad deposit—El Oro deposit (1).	19°45′	100°8′	do	3	3?		Same as 1	(†)	0		(4)		8.
2	Guadalupana deposits.	18°27′	100°7′	15 north of Arcelia, Guerrero.	160	0	Cía. Minera La Guadalupana.	Chimneys in silicified fracture zones in tuffs.	(*)	1,000	42	•A	40	32.
2a	Tlalchapa deposit—Guadalupana deposits (2).	18°27′	100°7′	do	160	0	do	Same as 2	(*)	(4)		(4)		8.

See footnotes at end of table.

TABLE 17.—*Location, ownership, production, reserves, and type of individual manganese deposits in Mexico*—Continued

Deposit No.	Name	Location: North latitude	Location: West longitude	Location: Direction and air-line distance from place named (in kilometers)	Distance by road or trail to railroad (in kilometers)	Distance by trail to road (in kilometers)	Owner or operator	Type of deposit; remarks	Date of most recent work	Production to March 31, 1943: Metric tons	Production to March 31, 1943: Percent of manganese	Reserves: Metric tons	Reserves: Percent of manganese	Source of information [1]
							Mexico—Continued							
2b	Dulce Nombre deposit.	18°27′	100°7′	1 north of the Guadalupana deposits (2).	160	0	Cia. Minera La Guddalupana.	Similar to 2	(*)	(4)	-----	(4)	-----	32.
2c	Rincón deposit	18°27′	100°8′	1 northwest of the Guadalupana deposits (2).	160	1	do	do	(†)	0	-----	C	-----	33, 38.
2d	Chaca deposit	18°26′	100°7′	1 south of the Guadalupana deposits (2).	160	1	María de Popoca, and others.	Flat body (manto) 10 meters long and 2 meters wide, cutting across layers of tuffs.	(*)	80	-----	C	40	32.
2e	María del Consuelo deposit.	18°26′	100°7′	Just south of the Chaca deposit (2d).	160	1	do	Similar to 2d	(*)	(4)	-----	(4)	-----	32.
2f	Jalón deposit	18°26′	100°8′	1.5 southwest of the Guadalupana deposits (2).	160	1		Similar to 2. 1 cut 15 meters long exposes ore body 1.5 meters wide, striking N. 20° W.	(†)	0	-----	C	30	33, 38.
2g	Tiempos Futuros deposits.	18°25′	100°7′	2 south of the Guadalupana deposits (2).	160	1	Cia. Minera La Guadalupana.	Similar to 2	1942	0	-----	B	30	32.
							Michoacan							
1	Ozumatlán deposit	19°44′	100°51′	30 east of Morelia	30	3?		(?)	(†)	0	-----	C?	-----	8.
2	Ciudad Hidalgo deposit.	19°45′	100°32′	3 from Ciudad Hidalgo.	3	3?		(?)	(†)	0	-----	C?	-----	8.
3	Eticuaro deposit	190°27′	101°0′	3 from Eticuaro	40	3?		(?)	(†)	0	-----	C?	-----	8.

							Morelos							
1	San Carlos deposit	18°40′	99°17′	8 northeast of Puente de Ixtla.	8	5?	Librado Ocampo	Fissure deposit in rhyolite. Very small.	(†)	0		C		5.
							Nayarit							
1	Tejabanes deposit	21°18′	104°8′	20 north of Hostotipaquillo, Jalisco.	45	25	F. M. Newton, and others.	Fissure deposit in schist? Probably consists of silicate or carbonate at depth.	1942	0		C?		31.
1a	San Rafael deposit	21°18′	104°8′	Adjacent to the Tejabanes deposit (1).	45	25	do	Similar to 1	1942	0		[4]		31.
							Nuevo Leon							
1	Peña deposit	26°03′	100°31′	3 north of Mina station.	5	3?	Epigmenio de la Peña.	(?)	(†)	100		C		10.
2	Santa Catarina deposit.	25°43′	100°27′	10 northwest of Monterrey.	3	3?		(?)	(†)	0		C		8.
3	Victoria deposit	24°0′	99°46′	3 from Zaragoza	80	(?)	Cía. Fundidora de Fierro y Acero de Monterrey, S. A.	(?)	(†)	0		C		2.
3a	Zaragoza deposit—Victoria deposit (3)?	24°0′	99°46′	do	80	(?)	do	(?)	(†)	0		[4]		2.
							Oaxaca							
1	Tindú deposit	17°35′	97°53′	30 southwest of Huajuapan.	100	15?		(?)	(†)	0		C?		8.
2	Duayaco deposit	17°30′	97°38′	20 southeast of the Tindú deposit (1).	80	10?		(?)	(†)	0		C?		8.
3	Tehuantepec deposit	16°27′	95°19′	15 northwest of Tehuantepec.	15	5?		(?)	(?)	0		C?		8.
4	Pochutla deposit	15°48′	96°27′	8 north of Pochutla	15	8?		(?)	(†)	0		C?		2.

See footnotes at end of table.

TABLE 17.—*Location, ownership, production, reserves, and type of individual manganese deposits in Mexico*—Continued

Deposit No.	Name	Location: North latitude	Location: West longitude	Location: Direction and air-line distance from place named (in kilometers)	Distance by road or trail to railroad (in kilometers)	Distance by trail to road (in kilometers)	Owner or operator	Type of deposit; remarks	Date of most recent work	Production to March 31, 1943: Metric tons	Production to March 31, 1943: Percent of manganese	Reserves: Metric tons	Reserves: Percent of manganese	Source of information[1]
							Puebla							
1	Poderosa deposit	20°7′	98°3′	10 south of Huauchinango.	10	10	Manuel Vite	Fissure deposit in volcanic rocks.	(*)	0		C	25	32.
1a	Salazar deposit—Poderosa deposit (1)?	20°7′	98°3′	do	10	10	Manuel Vite?	Same as 1	(*)	0		(4)		32.
2	Tenango deposit	19°55′	97°55′	25 southeast of the Poderosa deposit (1).	15	3?		(?)	(†)	0		C		8.
3	Tétela deposit	19°48′	97°48′	20 southeast of the Tenango deposit (2).	25	0		Fissure deposit? Type locality for the mineral johannsenite.	(†)	0		[12]C?	20	2.
4	Preciosa Sangre de Cristo mine.	19°23′	97°23′	10 northeast of Chalchicomula.	0?	0		Gangue in silver-lead ore. Vein 10 meters wide. Probably gives way to silicate or carbonate at depth.	(†)	0		B?	20	Burkart (1867).
5	Constancia mine	18°27′	98°3′	3 from Ahuatempan.	3?	3?	Rafael Rivera	?Outcrop is 1 by 2 meters.	(†)	0		C?		26.
6	Acatlán deposit	18°12′	98°0′	8 from Acatlán	30	8?		?Ore said to contain 5 percent of silica.	(†)	0		C?		21.
7	Mixteco deposit	18°10′	98°21′	30 west of Acatlán	60	5?	Hermenejildo Barrios.	(?)	(†)	0		C?		26.
7a	Piaxtla deposit—Mixteco deposit (7)?.	18°10′	98°21′	do	60	5?		(?)	(†)	0		(4)		8.
8	Cuajilote deposit	18°2′	98°3′	20 south of Acatlán	100	0	David Mujaes	Manganese oxides and braunite (?), in lenses in nearly vertical sericite schists.	(*)	1,000	41	B	25	32, 26.
8a	Petlalcingo deposit—Cuajilote deposit (8)?.	18°2′	98°3′	do	100	0	do	Same as 8	(*)	(4)		(4)		8.
8b	South Cuajilote deposit.	18°0′	98°3′	3 south of the Cuajilote deposit (8).	100	1		Similar to 8?	(†)	0		C		33, 26.

							Queretaro							
1	Maldonado deposit	20°45′	99°54′	50 east of Queretaro City.	50	5?	Fernando Maldonado.	? Vein said to be 1 meter wide.	(†)	0	-----	C?	-----	10.
							San Luis Potosí							
1	Montaña de Manganeso mine.	23°20′	101°47′	5 southwest of Santo Domingo.	100	0	Aureliano de León	Manganese oxides and braunite with silica, in veinlets and chimneylike bodies that replace tuffs.	(*)	19,000	42	A	40	35, 40.
1a	Gallardo deposit	23°20′	101°48′	Just northwest of the Montaña de Manganeso mine (1).	100	0	Praxedis Gallardo	Similar to 1. One cut 6 meters in diameter in May 1943.	(*)	0	-----	C	35	35.
1b	Cruz deposit	23°19′	101°47′	1 south of the Montaña de Manganeso mine (1).	100	0	Martín Sutti	Similar to 1	1942	1,000	44	C	-----	35.
2	Illescas deposits	23°9′	102°1′	12 southeast of Illescas.	80	3?	Amado Chapa	Probably similar to 1. Ore said to contain about 35 percent of manganese and 12 to 22 percent of silica.	(†)	0	-----	A	35	10.
2a	Prieta deposit	23°9′	102°1′	In the Illescas area (2).	80	3?	do	Similar to 2	(†)	0	-----	(4)	-----	10.
2b	Chapala deposit	23°9′	102°1′	do	80	3?	do	do	(†)	0	-----	(4)	-----	10.
2c	Jorilla deposit	23°9′	102°1′	do	80	3?	do	do	(†)	0	-----	(4)	-----	10.
2d	Santana deposit	23°9′	102°1′	do	80	3?	do	do	(†)	0	-----	(4)	-----	10.
3	San Antonio deposit	22°39′	101°48′	8 west of Salinas	8	1	Francisco Alfaro, and others.	Chimneylike deposit of manganese oxide ore in silicified zone in rhyolite rocks.	(†)	0	-----	C	30	35.
4	Victoria deposit	22°39′	100°25′	6 northeast of Guadalcázar.	20	6	Raul Oliva	Chimneylike deposit in limestone breccia near contact with granite stock.	1942	0	-----	B	20	35.
							Sinaloa							
1	Prieta deposit	26°0′	108°0′	30 northeast of Sinaloa City.	60	15?		(?)	(†)	0	-----	C?	-----	30.
2	Guamuchil deposit	25°40′	107°35′	60 east of Guamúchil	80	0	Cía. International Mines.	Fissure deposit in volcanic rocks. Ore difficult to sort to marketable grade.	(*)	150	38?	B?	30	4.
2a	Los Mochis deposit—Guamúchil deposit (2)?.	25°40′	107°35′	60 east of Los Mochis.	80	0	Niel Ward and others.	Same as 2	(?)	(4)	-----	(4)	-----	10.
3	Clyde Smith deposit	23°0′	105°48′	10 east? of Rosario	15?	10?	Clyde Smith	(?)	(†)	0	-----	C?	-----	10.

See footnotes at end of table.

TABLE 17.—*Location, ownership, production, reserves, and type of individual manganese deposits in Mexico*—Continued

Deposit No.	Name	Location: North latitude	Location: West longitude	Location: Direction and air-line distance from place named (in kilometers)	Distance by road or trail to railroad (in kilometers)	Distance by trail to road (in kilometers)	Owner or operator	Type of deposit; remarks	Date of most recent work	Production to March 31, 1943: Metric tons	Production to March 31, 1943: Percent of manganese	Reserves: Metric tons	Reserves: Percent of manganese	Source of information [1]
	Sonora													
1	Cunara deposit	31°8′	111°24′	45 southwest of Nogales.	50	3?		Fissure deposit?	(†)	0		C		8.
2	Independencia deposit.	31°15′	110°52′	6 southeast of Nogales.	4	0	T. J. Anderson	Fissure deposit in granite.	(*)	0		C	30	34.
3	Carr deposits	31°15′	109°41′	18 southwest of Agua Prieta.	20	0	Carfos Co.	Replacement of thin beds of limestone, parallel to bedding. Principally braunite.	(*)	3, 300	41	[14] A	40	35.
3a	Sáric deposit—Carr deposits (3)?.	31°15′	109°41′	do	20	0	Carfos Co.?	Probably same as 3	(*)	(4)		(4)		35.
4	Edmondson deposit	30°59′	110°15′	5 from Cananea	5	3?	Chas. H. Edmondson.	(?)	(†)	0		C?		10.
4a	Cananea deposit—Edmondson deposit (4)?.	30°59′	110°15′	do	5?	3?	Chas. H. Edmondson?.	(?)	(†)	0		(4)		8.
5	Gamer deposits	30°45′	110°43′	32 east of Imuris	45	0	W. L. Gamer	Veins in metamorphic rocks. Principally rhodochrosite, partly oxidized in weathered zone, with some sulfides.	(*)	500	40	[8] B	25	34.
5a	Shangrilá claim	30°45′	110°43′	In the Gamer area (5).	45	0	do	Similar to 5	(*)	(4)		(4)		34.
5b	Lost Horizon claim	30°45′	110°43′	Just east of the Shangrilá claim (5a).	45	0	do	do	(†)	(4)		(4)		34.
5c	San Antonio claim	30°46′	110°42′	3 northeast of the Shangrilá claim (5a).	48	0	do	do	1942	(4)		(4)		34.
5d	Victoria claim	30°46′	110°42′	do	48	0	do	do	1942	(4)		(4)		34.
5e	Spirit 1 and spirit 2 claims.	30°46′	110°42′	do	48	0	do	do	1942	(4)		(4)		34.
6	Antillas deposit	30°40′	110°58′	3 west of Magdalena.	3	0	Juan Antúnez	Lenses along shear zone between gneiss and schist.	(*)	3, 200	40	A	30	35.
6a	Puerto Rico deposit	30°41′	110°58′	1 north? of the Antillas deposit (6).	4	0	do	Manganese oxides in fissures.	(*)	(4)		(4)		4.

6b	Cubana deposit	30°42′	110°58′	3 north of the Antillas deposit (6).	4	0	do	Fissure deposit between limestone and gneiss. Principally black calcite, difficult to concentrate.	(*)	(4)	-----	B	25?	4.
7	Dardeneas deposita	30°28′	110°56′	20 southeast of Santa Ana.	35	0?	Cía International Mines.	Fissure deposit in volcanic rocks. Mainly braunite with much silica.	(*)	50	40	C	25?	33, 4.
8	Guadalupana deposits.	30°23′	110°50′	32 southeast of Santa Ana.	45	5	George W. Greenwood.	Black calcity in fissures in volcanic rocks.	(*)	50	47	B	35	35.
8a	Azabache and San Salvador deposits—Guadalupana deposits (8)?.	30°23′	110°50′	do	45	5	George W. Greenwood?.	Same as 8?	(*)	(4)	-----	(4)	-----	8.
8b	Cucurpe deposit (Guadalupana deposits (8)?).	30°23′	110°50′	do	45	5	do	do	(*)	(4)	-----	(4)	-----	2.
8c	San Francisco deposit.	30°23′	110°50′	Just south of the *Guadalupana* deposits (8).	45	5	George W. Greenwood.	Similar to 8	(†)	0	-----	C	30	35.
8d	Ojo Negro deposit	30°24′	110°51′	2 northwest of the Guadalupana deposits (8).	45	5	do	Manganese oxides in fault between rhyolite and tuff.	1942	0	-----	C	20	35.
9	Gallito de Manganeso claim.	30°24′	109°35′	8 east of Nacozari	8	8	T. B. Engelhart	Fissure deposit in volcanic rocks. Silica content more than 18 percent.	1942	50	40	B	25?	10.
9a	Nacozari deposit (Gallito de Manganeso claim (9)?).	30°24′	109°35′	do	8	8	do	Same as 9	1942	(4)	-----	(4)	-----	10.
10	Dos Cabezas deposit	30°21′	108°38′	70 west of Casas Grandes, Chihuahua.	100	0	Antonio Espinosa	Stringers in volcanic rocks. Silica content over 18 percent.	(†)	0	-----	C	-----	9.
11	Isla Tiburón deposit	28°47′	112°20′	South end of Isla Tiburón.	[5] 3?	3?		(?)	(†)	0	-----	C?	-----	8.
12	La Dura deposits	28°20′	109°24′	17 east of La Dura	20	?	Lee Whiting	Fissure deposits in volcanic rocks. Veins said to range from 15 to 120 centimeters in width.	(†)	0	-----	C	25?	30.
13	San Vicente deposits	27°34′	109°44′	20 east of Esperanza	23	10?	Tom Kelly	Fissure deposits	1942	50	30	C	-----	4.
14	Tesia deposit	27°20′	109°23′	20 northeast of Navojoa.	23	10?		? Said to be large and to average 20 percent of manganese.	(†)	0	-----	B?	-----	30.
14a	Navojoa deposit (Tesia deposit (14)?).	27°20′	109°23′	do	23	10?		Same as 14?	(†)	0	-----	(4)	-----	8.

See footnotes at end of table.

TABLE 17.—*Location, ownership, production, reserves, and type of individual manganese deposits in Mexico*—Continued

Deposit No.	Name	Location			Distance by road or trail to railroad (in kilometers)	Distance by trail to road (in kilometers)	Owner or operator	Type of deposit; remarks	Date of most recent work	Production to March 31, 1943		Reserves		Source of information [1]
		North latitude	West longitude	Direction and air-line distance from place named (in kilometers)						Metric tons	Percent of manganese	Metric tons	Percent of manganese	
							Zacatecas							
1	Hércules deposit	24°52′	101°38′	3 north of San Pedro Ocampo.	30	6	Leopoldo Villareal, Jr.	Chimneylike deposit in massive limestone.	(*)	20	40	B	20	32.
1a	Mazapil deposit (Hércules deposit (1)).	24°52′	101°38′	do	20	6	do	Same as 1	(*)	(4)		(4)		8.
1b	Ramírez deposit	24°49′	101°41′	6 southwest of San Pedro Ocampo.	15?	10?	do	Similar to 1, but leaner.	(†)	0		C		36.
1c	Trinidad deposit	24°49′	101°41′	do	15?	10?	do	Similar to 1. Very lean.	(†)	0		C		36.
2	Aldama deposit	24°17′	103°18′	6 east of Juan Aldama.	80	10?		(?)	(†)	0		C?		8.
3	Nieves deposit	24°2′	102°52′	7 east of Nieves	20	7?		(?)	(†)	0		C?		29.
4	Santa Lucía deposit	23°40′	103°44′	1? west of Sombrerete.	12	5?		(?)	(†)	0		C?		8.
5	Tinajas deposit	23°29′	102°39′	1 south of Cañitas	18	0	Ramón Molleda	Chimneylike bodies in silicified rhyolitic rocks.	(*)	50	40	[14] A	20	35.
5a	Lamentos deposit	23°35′	102°33′	1 east of Cañitas	15	3?	Francisco Gonzáles	Similar to 5, but leaner in manganese and higher in silica.	(r)	0		B	20?	19.
5b	Jacales deposit	23°31′	102°39′	3 north of Tinaja deposit (5).	12	2?	Ramón Molleda	Similar to 5, but smaller.	(†)	0		B	20?	33, 19.
5c	Molleda deposits	23°25′	102°35′	1 southeast of Tinaja deposit (5).	20	2?	do	Similar to 5, but small and highly siliceous.	(†)	0		B	20?	19.
6	Manganita deposit	23°37′	102°20′	3 east of Cañitas	42	0	Aureliano de León	Lenses in silicified rhyolite tuffs.	(*)	3, 500	40	[14] A A	40	35.
6a	Humo de Oro claim	23°37′	102°20′	Just east of the Manganita deposit (6).	42	0	do	Similar to 6, but smaller.	(*)	(4)		(4)		35.
6b	Mezquite deposit	23°37′	102°20′	Just northwest of the Manganita deposit (6).	42	0	do	Similar to 6. Vein 60 meters long and from 1 to 2.5 meters wide, striking east and dipping 70° S.	(*)	(4)		(4)		35.

6c	Cerrito claim	23°37′	102°21′	Just west of the Manganita deposit (6).	41	0	do	Adjoins 6, but contains no vein.	(*)	(4)	-----	(4)	-----	35.
6d	Tinajita deposit	23°37′	102°19′	Just east of the Humo de Oro claim (6a).	42	0	Manuel Ibarguengoita.	Similar to 6. One cut 15 meters in diameter exposes vein 2 meters wide.	(*)	0	-----	14A	40	35.
7	Abundancia mine	23°37′	102°12′	Northeast of Villa de Cos.	40	0	Financiera Minera	Lenses, chimneys, and veinlets in partly silicified tuffaceous clays, which in places are replaced along bedding planes.	(*)	15 5,000	42	14A	40	35.
7a	Colorado deposit—Abundancia mine (7).	23°37′	102°12′	do	40	0	do	Same as 7	(*)	(4)	-----	(4)	-----	35, 40.
8	San Felipe de Jesús deposit.	23°28′	102°22′	45 east of Cañitas	50	0	Aureliano de León	Replacement bodies along fissures and nearly flat bedding planes, in partly silicified tuffs.	(*)	1,000	40	14B	40	35.
8a	Villa de Cos deposit—San Felipe de Jesús deposit (8).	23°28′	102°22′	do	50	0	do	Same as 8	(*)	(4)	-----	(4)	-----	8.
8b	Carmen deposit	23°28′	102°22′	Just west of the San Felipe de Jesús deposit (8).	50	0	Ramón Azner	Similar to 8	(*)	500	40	14B	40	35.
8c	Tenango deposit	23°31′	102°17′	10 northeast of the San Felipe de Jesús deposit (8).	48	0	Aureliano de León	do	(*)	500	40	14A	40	35.
8d	Pirolusita deposit	23°31′	102°17′	Just north of the Tenango deposit (8c).	48	0	do	Similar to 8, but leaner in manganese and more siliceous. Explored by means of seven cuts.	(*)	(4)	-----	(4)	-----	35.
8e	Ibarguengoitia deposit.	23°31′	102°18′	Just west of the Pirolusita deposit (8d).	48	0	Manuel Ibarguengoitia.	Similar to 8, but more siliceous. Three zones of replacement that strike northeast and dip vertically have been explored by ten cuts.	(*)	50	40	14B	40	35.
8f	Estrellas deposit	23°32′	102°22′	8 north of the San Felipe de Jesús deposit (8).	45	2?	Salvador Salvoy	Similar to 8? Assays of selected ore gave 43 percent Mn and 6 percent SiO_2.	(†)	0	-----	B	25?	19.
8g	Salvador deposit	23°32′	102°22′	do	45	2?	do	Similar to 8?	(†)	0	-----	B	25?	19.
9	Negra deposit	23°10′	102°54′	7 southwest of Fresnillo.	7	0	Alberto Stephano	Siliceous replacement zone in rhyolitic rocks.	(*)	11,000?	40	14A	30	35.

See footnotes at end of table.

TABLE 17.—*Location, ownership, production, reserves, and type of individual manganese deposits in Mexico*—Continued

Deposit No.	Name	Location: North latitude	Location: West longitude	Location: Direction and air-line distance from place named (in kilometers)	Distance by road or trail to railroad (in kilometers)	Distance by trail to road (in kilometers)	Owner or operator	Type of deposit; remarks	Date of most recent work	Production to March 37, 1943: Metric tons	Production to March 37, 1943: Percent of manganese	Reserves: Metric tons	Reserves: Percent of manganese	Source of information[1]
	Zacatecas—Continued													
9a	Fresnillo deposit—Negra deposit (9).	23°10′	102°54′	7 southwest of Fresnillo.	7	0	Alberto Stephano	Same as 9	(*)	(4)		(4)		8.
9b	Cerro del Fierro deposit—Negra deposit (9).	23°10′	102°54′	do	7	0	do	do	(*)	(4)		(4)		8.
10	San Pedro deposit	22°27′	102°20′	22 southwest of Ojo Caliente.	10	5?		(?)	(†)	0		C		8.
11	Tinaja deposit	22°28′	101°52′	6 west of Palmireto station.	6	0	Martín Sutti	Chimneys in zone of silicified rhyolite tuffs.	1942	0		[14] B	30	35.
11a	Ortega deposit	22°35′	101°55′	17 northwest of the Tinaja deposit (11).	25	5?	Ramón Molleda	Similar to 11	(†)	0		B	25?	19.
12	Pinos deposit	22°21′	101°33′	3 from Pinos	3	3?		Same as 11?	(†)	0		C		8.

[1] Names followed by dates should be referred to the bibliography, pp. 285-289. Numbers standing alone should be referred to the list of sources of unpublished information on pp. 289-290 of this table.

[2] Production to January 1946 is 87,031 tons for the Lucifer district; all but a few hundred tons have come from the main Lucifer deposit.

[3] Numbers in parentheses after a name refer to deposit numbers.

[4] Reserves or production included with estimate next above.

[5] No railroad, either on island or on peninsula; distances are from the sea.

[6] No road on island.

[7] Production to June 1944 is estimated to have been 50,000 tons.

[8] Crystalline rhodochrosite.

[9] Not included in total for State, in order to avoid duplicate tonnages.

[10] Production to May 31, 1943.

[11] Mostly rhodonite.

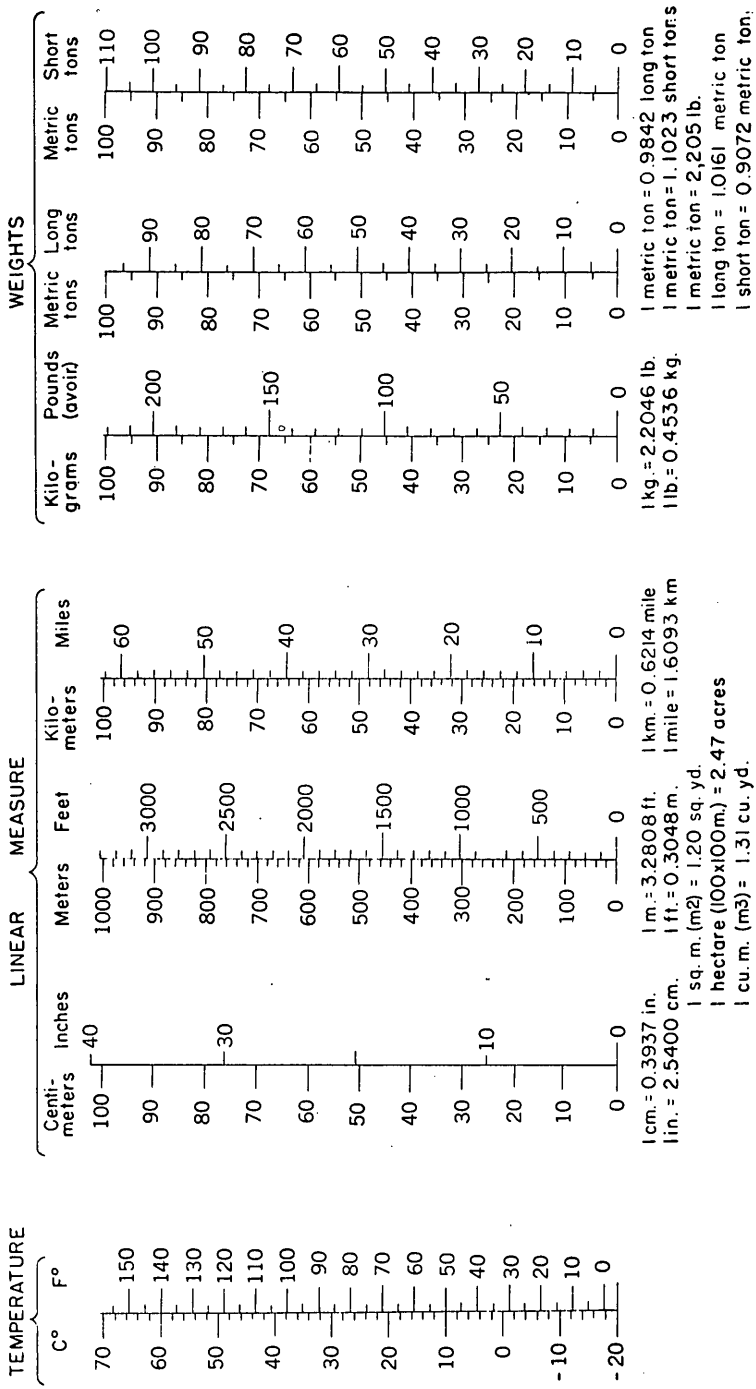
[12] Replaced by johannsenite with depth.

[13] As a gangue in silver-lead ores; oxides at surface but rhodochrosite or rhodonite at depth.

[14] Siliceous ore that resembles braunite.

[15] Production to May 1944 was 12,000 tons.

METRIC EQUIVALENTS



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