Iron-Ore Resources of the United States Including Alaska and Puerto Rico, 1955

By MARTHA S. CARR *and* CARL E. DUTTON

CONTRIBUTIONS TO ECONOMIC GEOLOGY

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A survey of iron-ore resources of the United States, with selected bibliography and tables of iron-ore reserves and potential ore

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IRON-ORE RESOURCES OF THE UNITED STATES, INCLUDING ALASKA AND PUERTO RICO, 1955

By MARTHA S. CARR and CARL E. DUTTON

ABSTRACT

The importance of iron ore, the basic raw material of steel, as a fundamental mineral resource is shown by the fact that about 100 million long tons of steel is used annually in the economy of the United States, as compared with a combined total of about 5 million long tons of copper, lead, zinc, and aluminum. Satisfying this annual demand for steel requires about 110 million tons of iron ore and 70 million tons of scrap iron and steel.

The average annual consumption of iron ore in the United States from 1951 to 1955, inclusive, was about 110 million long tons, which is about twice the annual average from 1900 to 1930. Production of iron ore in the United States in this 5-year period averaged approximately 100 million long tons annually, divided by regions as follows (in percent): Lake Superior, 84.1; southeastern, 6.7; western, 6.7; northeastern, 1.4; and central and gulf, 1.1.

Mining of iron ore began in the American Colonies about 1619, and for 225 years it was limited to eastern United States where fuel and markets were readily available. Production of iron ore from the Lake Superior region began in 1846; the region became the leading domestic source by 1890, and the Mesabi range in Minnesota has been the world's most productive area since 1896. Proximity of raw materials, water transportation, and markets has resulted in centralization of the country's iron and steel industry in the lower Great Lakes area. Increased imports of iron ore being delivered to eastern United States as well as demands for steel in nearby markets have given impetus to expansion in the steel-making capacity in this area.

The four chief iron-ore minerals—hematite, liminite, magnetite, and siderite—are widely distributed but only locally form deposits of sufficient tonnage and grade to be commercially valuable at the present time. The iron content of these minerals, of which hematite is the most important, ranges from 48 percent in siderite to 72 percent in magnetite, but as these minerals are associated with other rock-forming minerals, the iron content of marketable ore has a lower range—from 30 to 67 percent.

Chemical constituents other than iron also are important in determining the marketability of iron ore. Although some iron ores can be used in the blast furnace as mined, others must first be improved either chemically by reduction of undesirable constituents, or physically by aggregation. Phosphorus and sulfur

particularly are common deleterious elements; excessive silica is also undesirable but within certain limits can be controlled by additional flux. Lime and magnesia are beneficial in specified amounts because of their fluxing qualities, and a small amount of alumina improves the fluidity of slag. Manganese is especially desirable as a deoxidizing and desulfurizing agent. Titanium, chromium, and nickel must also be considered in the use of ore containing these elements.

The principal iron-ore deposits in the United States have been formed by three processes. Hematite-bearing bedded deposits such as those at Birmingham, Ala., are marine sedimentary rocks which, except for weathering along the outcrop, have remained practically unaltered since deposition. Deposits of the Lake Superior region, also in sedimentary strata, originally had a slightly lower iron content than those at Birmingham, but ore bodies of hematite and limonite were formed by removal of other constituents in solution after deposition of the beds, with a relative increase of iron content in the material remaining. Limestone adjacent to igneous intrusions has been replaced by magnetite deposits at Cornwall, Pa., and by hematite-magnetite deposits near Cedar City, Utah. Magnetite deposits in New Jersey and in the Adirondack Mountains of New York are generally believed to have been formed by replacement of grains of other minerals in metamorphic rocks.

Iron-ore resources are made up of reserves of iron ore, material usable under existing economic and technologic conditions; and potential ore, material likely to become usable under more favorable conditions. The tonnage and grade of material of combined reserves and potential ore in each of the deposits known or believed to contain at least 200,000 long tons of iron-ore resources are tabulated in this report, and numerous sources of additional information are given in a selected bibliography.

The total domestic iron-ore resources are estimated at approximately 75,000 million long tons of crude ore. About 10,000 million tons of the resources is reserves of crude ore that will probably yield 5,500 million tons of concentrates and direct-shipping ore. About 65,000 million tons is potential ore and may yield 25,000 million tons of concentrates and some direct-shipping ore.

INTRODUCTION

Iron ore is a fundamental mineral resource from which iron is extracted to make steel for numerous uses in nearly all phases of the present economy. The importance of iron ore is emphasized by the fact that approximately 100 million long tons of steel is consumed annually in the United States, as compared with a total consumption of about 5 million long tons of copper, lead, zinc, and aluminum. Continued or increased demands for steel can be satisfied only by further mining and consequent depletion of nonrenewable iron-bearing material in the earth. Percentage of depletion is a relative matter, however, and must be appraised by considering that exploration has discovered only part of the total potential supply of iron-bearing material, and that advances in beneficiation are significantly increasing the proportion of the total supply that is suitable for steel making.

The purpose of this report is to summarize available information concerning iron-ore resources in the United States in order to provide a general background for understanding and appraising the present status of this basic commodity. Iron-ore resources include reserves, material usable under existing economic and technologic conditions; and potential ore, material likely to become usable under more favorable conditions. Reserves are made up of both direct-shipping ore, which is of usable grade as mined, and concentrates, which are obtained by various methods of beneficiation.

For ease of description in this report, iron deposits in continental United States are grouped geographically into five regions, as shown below. Alaska, which became a State after this report was prepared, and Puerto Rico are discussed after the regional descriptions.

Northeastern	*Southeastern*	*Lake Superior*	*Central and gulf*	*Western*
Connecticut	Alabama	Michigan	Arkansas	Arizona
Maine	Delaware	Minnesota	Illinois	California
Massachusetts	Florida	Wisconsin	Indiana	Colorado
New Hampshire	Georgia		Iowa	Idaho
New Jersey	Kentucky		Kansas	Montana
New York	Maryland		Louisiana	Nevada
Ohio	Mississippi		Missouri	New Mexico
Pennsylvania	North Carolina		Nebraska	Oregon
Rhode Island	South Carolina		North Dakota	Utah
Vermont	Tennessee		Oklahoma	Washington
	Virginia		South Dakota	Wyoming
	West Virginia		Texas	

CONSUMPTION OF IRON ORE

An average of 110 million long tons of iron ore and 70 million tons of scrap iron and steel are required annually to meet the demand for steel production in the United States. The amount of iron ore consumed has generally increased since the beginning of the industry, and reached 125 million long tons for the year 1955 (fig. 7). The average annual consumption from 1900 to 1930 was about 55 million tons, from 1940 to 1950 about 95 million tons, and from 1951 to 1955, inclusive, about 110 million tons. The current rate of consumption is thus more than double the rate from 1900 to 1930, and further increases will be needed to provide ore for expansion of furnace capacity. Although domestic production of large amounts of high-grade ore will continue, the need for increased supplies of iron ore will be met by using more concentrates from lower grade ore and by importing more ore.

PRINCIPAL SOURCES OF IRON ORE

The principal sources of iron ore in the United States are widely distributed, as shown on plate 2. The trend in production of direct-shipping iron ore and concentrates in the United States, by regions,

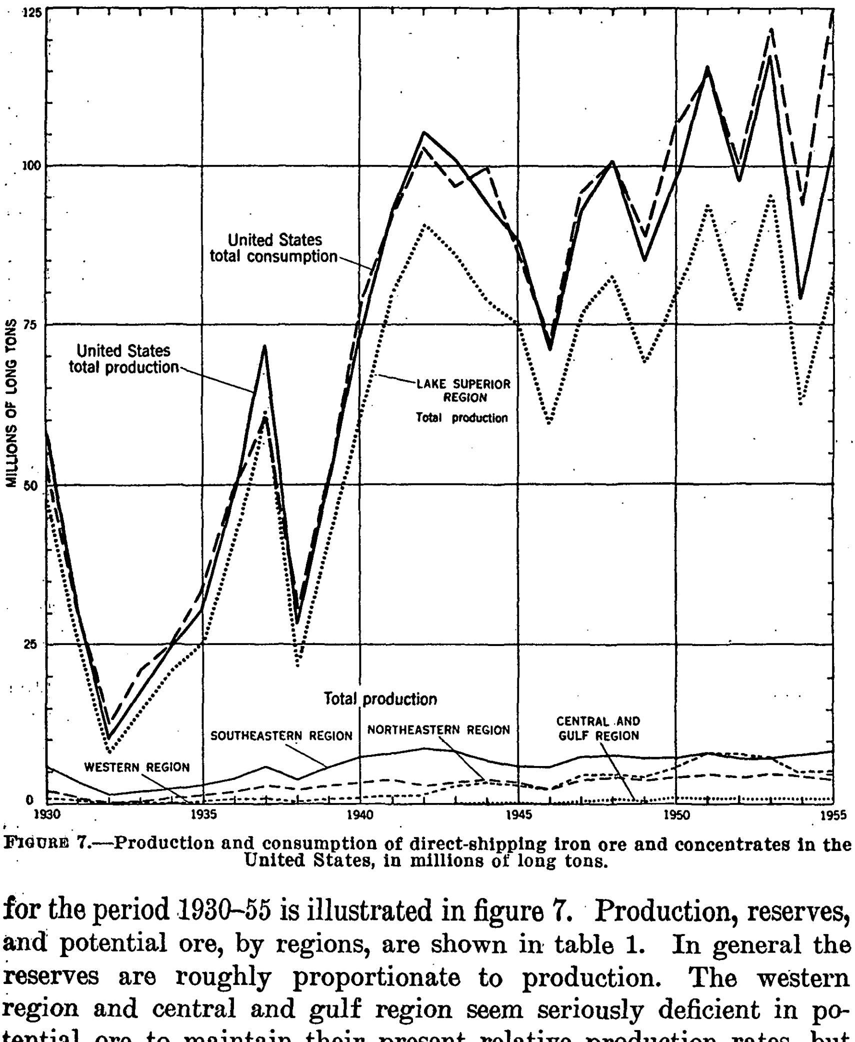

FIGURE 7.—Production and consumption of direct-shipping iron ore and concentrates in the United States, in millions of long tons.

for the period 1930–55 is illustrated in figure 7. Production, reserves, and potential ore, by regions, are shown in table 1. In general the reserves are roughly proportionate to production. The western region and central and gulf region seem seriously deficient in potential ore to maintain their present relative production rates, but data for iron-ore resources in these regions are probably less complete or more conservatively interpreted than for other regions, which have been the principal sources of iron ore for many years. The Lake Superior and southeastern regions have the major share of reserves (84.6 percent) and potential ore (94.6 percent) and presumably will continue to produce the bulk (90.8 percent, 1951–55) of domestic iron ore.

GEOGRAPHIC PATTERN OF IRON AND STEEL INDUSTRY

Quantity and quality of ore are foremost considerations in iron-ore economics, but additional factors that determine the geographic pattern of the iron and steel industry are adequate supplies of fuel and

TABLE 1.—*Production of direct-shipping iron ore and concentrates, 1951–55, and estimated iron-ore resources, by regions, 1955, in the United States*

Region	Production [1]		Resources (estimated tonnage)			
			Reserves [2]		Potential ore [3]	
	Millions of long tons	Percentage of total	Millions of long tons	Percentage of total	Millions of long tons	Percentage of total
Northeastern	6.70	1.4	300	5.5	2,850	4.4
Southeastern	32.64	6.7	610	11.2	11,220	17.3
Lake Superior	405.56	84.1	4,000	73.4	50,000	77.3
Central and gulf	5.25	1.1	50	.9	116	.2
Western	32.22	6.7	490	9.0	500	.8
Total	482.37	100.0	About 5,500	100.0	About 65,000	100.0

[1] Production figures from U.S. Bureau of Mines.
[2] Direct-shipping ore and concentrates usable under present technologic and economic conditions.
[3] Probably usable, partly as direct-shipping ore but mostly after beneficiation, under more favorable technologic and economic conditions.

flux, markets for finished products, and favorable transportation costs.

Common practice in smelting has required a mixture of iron ore and solid fuel, which was first charcoal, later was coal, and now is coke. The large quantities of coal needed for smelting determined the early establishment of smelting centers in or near coal-producing areas such as Pittsburgh, Pa., Birmingham, Ala., and later at Pueblo, Colo., and near Provo, Utah, as markets developed with westward migration and settlement.

The change from coal to coke and the increased efficiency of furnaces, which has lowered the ratio of solid fuel to iron ore, have permitted some changes in the customary pattern of shipping iron ore to sources of coking coal. The principal factors that have determined these changes have been costs of transporting raw materials and finished products. The much lower cost of transportation by water than by rail, combined with ready access to markets for finished products, has been responsible for development of smelting centers near Detroit, Chicago, Trenton, and Baltimore. The great production of iron ore from the Lake Superior region, the low-cost transportation on the Great Lakes, and the large supplies of coal from Pennsylvania, West Virginia, and Kentucky have brought about the centralization of approximately 75 percent of the country's iron and steel industry, as of 1955, in the lower Great Lakes area—between Pittsburgh and Buffalo on the east and Chicago on the west.

Steel manufacturing has also developed in some localities without the advantage of low-cost transportation by water or proximity to coking coal. Steel for the market area served from Provo, Utah, is made of iron ore shipped from the southwestern part of the State and coking coal from northeastern Utah and south-central Colorado. Iron ore from the Eagle Mountains in southeastern California and coal from Utah are raw materials for steel made near Los Angeles for the adjacent market area. Increased amounts of imported iron ore arriving on the eastern seaboard of the United States and demands for steel in nearby markets have prompted growth of steel-making capacity in this area. The amount of iron ore received at Atlantic and Gulf of Mexico ports in 1950 was about 6.5 million tons, which was 6 percent of the total domestic consumption of iron ore for that year, and the amount in 1956 was about 30 million tons or almost 14 percent. The principal related development in the making and fabrication of steel has been the building of a 6.2 million net-ton steel plant at Sparrows Point, Md., and a 2.2 million ingot-ton mill at Morrisville, Pa., across the Delaware River from Trenton, N.J.

HISTORY OF IRON-ORE PRODUCTION

Mining and smelting of iron ore in the Colonies that later formed the United States of America began in Virginia at least as early as 1619, and in the New England area a few decades later. These operations were locally important but had limited capacity and potentiality because they were dependent upon small supplies of iron ore in nearby bogs and upon use of charcoal for fuel.

Deposits of iron ore in southeastern New York, northern New Jersey, and eastern Pennsylvania, which were being mined by 1750, were conducive to a moderate expansion of the iron industry because they were much more extensive than bog ores.

The next important expansion began about 1820 when coal of the Appalachian area was used for making coke, which replaced charcoal and coal in smelting operations. This change facilitated a greatly increased output of iron to meet the expanding needs of transportation, commerce, and agriculture that accompanied the westward movement of settlers.

In several respects the latter half of the 19th century was the most important period in the history of iron-ore production in the United States. Iron ore in the Birmingham district, Alabama, was first smelted in blast furnaces about 1865, with bituminous coal; the use of coke began about a decade later. The major events in this half century were, however, the exploration and development of the deposits in the Lake Superior region, including the beginning of production from the Mesabi range in 1892.

Iron-ore production in the United States since 1900 has increased persistently, though with fluctuations related to economic cycles and wars. A small but locally important part of the increased output since 1943, during the Second World War, has come with the initiation or expansion of production from deposits in the central and gulf region and the western region.

The northeastern region had furnished a little more than 200 million tons of iron ore through 1955; production from New York was about 50 percent of the total, Pennsylvania 30 percent, and New Jersey 20 percent. The earliest mining of iron ore in this region was probably in New Jersey in 1685; the Dover district, which is the principal area of production, has been mined since 1710. The Cornwall mine in southeastern Pennsylvania, which began producing in 1740, is the oldest continuously operating mine in the United States and has been the principal producer in the State. The Adirondack district has been the chief source of iron ore from New York, where deposits have been mined since 1775.

The total production of iron ore in the southeastern region through 1955 was probably about 350 million tons, 80 percent of which has come from the Birmingham district, Alabama, where mining possibly began before 1818.

Slightly more than 3,000 million tons of iron ore had been shipped through 1955 from the part of the Lake Superior region that is in the United States. Approximately two-thirds of the total came from the Mesabi range, Minnesota; the Vermilion and Cuyuna ranges, also in Minnesota, have produced 6 percent of the regional total. The earliest mining in this region was in 1846 in the Marquette range, Michigan; total production of all ranges in this State has been about 25 percent of the total for the region. Mining in the Wisconsin part of the region began in 1884 and has provided 2 percent of the regional total.

Total iron-ore production in the central and gulf region through 1955 was slightly less than 30 million tons. Mining of iron ore began in Missouri in 1845 and has produced almost two-thirds of the regional total; the other third has been produced in Texas since 1855.

Iron ore produced in the western region totaled slightly more than 70 million tons through 1955, mostly from 3 States. Mining of iron ore in Wyoming began in 1868 and has provided a little more than 20 million tons. Iron ore in Utah was first mined in 1874, but 85 percent of a total production of almost 40 million tons has been mined since 1942. The earliest mining of iron ore in California was 1881, but most production has also been since 1942 and has totaled a little more than 10 million tons.

The total production of direct-shipping iron ore and concentrates in the United States, through 1955, was 3,650 million long tons, derived in percentage by regions as follows: Lake Superior, 82.19; southeastern, 9.59; northeastern, 5.48; western, 1.92; and central and gulf, 0.82 (chart *B* on pl. 2, in pocket).

MINERALOGY AND GEOLOGY OF IRON ORES

PRINCIPAL IRON-ORE MINERALS

Iron, a common chemical element, is fourth in order of abundance in the earth's crust and constitutes approximately 5 percent of it. This element seldom occurs in the native, or metallic, state but is generally combined with other elements in a great variety of minerals. Metallic iron can be economically extracted at the present time, however, from only a few of these compounds or iron-bearing minerals (see table below).

Composition of the principal iron-ore minerals

Mineral and commercial name	Chemical formula	Composition (percent)			
		Iron	Oxygen	Carbon	Water
Magnetite (magnetic ore)	Fe_3O_4	72. 4	27. 6	0	0
Hematite (red or gray ore)	Fe_2O_3	69. 9	30. 1	0	0
Limonite (brown ore)	[1]	60. 0	26. 0	0	14. 0
Siderite (carbonate ore)	$FeCO_3$	48. 3	41. 4	10. 3	0

[1] Limonite is a variable mixture of hydrated iron oxides, mostly goethite—FeO(OH); the composition given in this table is average.

The iron-ore minerals are most readily distinguished from each other by color, as indicated by the commercial names "red or gray ore" and "brown ore" for ore composed of hematite and limonite, respectively; all magnetite is black, and most siderite is gray. Specular hematite, which only locally constitutes important parts of domestic iron-ore deposits, comprises black plates or scales with brilliant metallic luster that are red when pulverized or scratched. Magnetite is generally of octahedral form when not massive, and siderite of rhombohedral form; hematite and limonite are commonly so finely granular as to be of earthy appearance. Magnetite is further characterized by being attracted by a magnet, and some specimens are themselves magnetic (lodestone).

The chief minerals in ores now being mined are hematite, limonite, and magnetite; hematite is the most widely distributed and important. Siderite is currently being produced in east Texas, but in general it is of interest principally because of its alteration, in many places, to limonite.

Because most iron deposits contain other minerals and host rock, the ores are slightly to considerably lower grade than the ore minerals themselves.

IMPURITIES

The chemical constituents of minerals associated with iron-ore minerals are commonly designated as oxides—silica, alumina, lime, and magnesia; or as elements—sulfur, phosphorus, manganese, titanium, chromium, and nickel. Some of these constituents, which in general are referred to as impurities, have deleterious effects whereas others are beneficial. Phosphorus and sulfur are deleterious and must be reduced to acceptable amounts in smelting operations; they consequently determine to a large degree the marketability of the ores. Although some silica in ore is needed to form slag, which separates to a certain degree associated impurities from molten iron during smelting, excessive silica must also be removed. This may be done either by mill treatment before smelting or by proportionally increasing the flux in the blast furnace. Lime and magnesia are desirable within certain limits for their fluxing qualities; and alumina, also in restricted amount, is desirable because it improves fluidity of the slag. Manganese has a strong affinity for oxygen and sulfur and is desirable for removing these elements from the steel, as well as for adding toughness to it. Titanium in excessive amounts may cause accretion in the furnace and is objectionable unless sufficiently abundant to justify its recovery as a byproduct from slag. Chromium and nickel are also generally undesirable in iron ore, although some ore containing these elements has been used in the manufacture of steel for special purposes.

MARKETABLE GRADES

The range in percentage of the principal constituents of marketable iron ores and concentrates, by regions, is given in table 2. Depending largely upon local conditions, ore containing greater or lesser amounts of the constituents shown in the table can be mined. Improvements in beneficiation methods and metallurgical processes may increase the range.

TYPES OF IRON-ORE DEPOSITS

The term "iron deposit" is used in this report in a very general geologic sense for masses in which iron-ore minerals are abundant; the occurrences may or may not be commercially valuable at the present time. "Iron ore" and "iron-ore deposit" refer to occurrences that are, may be, or are believed to be, sources from which metallic iron can be obtained profitably at the present time. No single term seems especially appropriate to designate the great variety of noncommercial occurrences.

Iron-ore deposits and, generally, much associated lower grade material have been formed by a variety of geologic processes and combinations of processes, but three general types of deposit are most significant. These are bedded, replacement and vein, and residual.

TABLE 2.—*Approximate chemical composition, in percent, of direct-shipping ore and concentrates in the United States, by regions, 1955*

[Source, U.S. Bureau of Mines: includes only those domestic mines reporting]

	Northeastern [1]		Southeastern [2]		Lake Superior [3]			Central and gulf [4]		Western [5]		
	Magnetite	Hematite	Hematite	Limonite	Magnetite	Hematite	Limonite	Hematite	Limonite	Magnetite	Hematite	Limonite
Fe	56–66	67	36–37	38–52	58–62	43–60	49–54	53	42–55	52–63	50–60	53–60
Mn	0.06–0.35	0.05	----	1–6	0.19–0.36	0.065–9	1.07–1.21	----	0.037–0.15	Trace–0.38	0.05–0.08	----
P	0.005–1	0.14	0.26–31	0.15–0.65	0.010–0.023	0.010–0.483	0.252–2.74	----	0.04–0.35	0.006–0.49	0.079–0.60	----
S	0.02–5	0.17	0.03	----	----	0.004–9	0.17	----	0.12–0.50	0.001–0.19	0.027–0.355	----
SiO_2	2–10	5	14–16	5–23	7.62–10.52	4–44	7–9	----	12–20	0.126–11	7–17	----
CaO	0.8–2	0.73	11–19	----	0.31–0.32	0.05–14	----	----	0.02–0.14	0.15–3	0.9–3	----
H_2O	0.18–9	5	1–14	2–21	3.92–9.66	0.81–17	9–11	----	0.10–7	0.023–4	2–6	19.0

[1] Includes only New Jersey, New York, and Pennsylvania.
[2] Includes only Alabama, Georgia, and Tennessee.
[3] Includes Michigan, Minnesota, and Wisconsin.
[4] Includes only Missouri, South Dakota, and Texas.
[5] Includes only California, Colorado, Montana, Nevada, New Mexico, Oregon, Utah, Washington, and Wyoming.

Bedded iron deposits are sedimentary layers that accumulated by precipitation of iron compounds in bodies of water. The deposition was in bogs, lakes, or seas; and the iron deposits are associated with the normal sequences of strata formed in those environments. Bedded iron deposits are generally very extensive, but only a part of the material is ore. Examples of bedded iron deposits in the United States are (a) taconite or unenriched iron-formation in the Lake Superior region; (b) iron-formation of Clinton type in eastern and southeastern United States, especially the Birmingham district, Alabama; and (c) sideritic beds in Pennsylvania and Ohio.

Iron deposits of the replacement and vein type are massive or tabular bodies of iron-ore minerals that have taken the place of preexisting rock-forming minerals or have filled voids in the rock, especially openings along fractures. Constituents to form the iron-ore minerals were presumably derived from magmatic sources in the hydrothermal variety of replacement and vein deposits and from products of rock weathering transported by ground water in the surficial variety. Examples of replacement and vein deposits of hydrothermal origin are the iron ores at Cornwall, Pa.; in the Iron Springs district, Utah; in northern New Jersey; and several ore deposits in the Adirondack district of New York. Replacement, vein, and cavity-filling deposits of surficial variety are the limonitic ore of the Russellville district, Alabama, and in part the sideritic and limonitic ore of eastern Texas.

Residual iron deposits have formed by decomposition of a wide variety of rocks whose original iron content has been relatively increased by removal of nonferrous constituents. The deposits are hematite or limonite or both that were originally in the rock or were formed from iron-bearing carbonate or silicates. The principal residual iron-ore deposits have formed from lower grade bedded deposits and consequently have similar characteristics. Other residual deposits of iron ore are commonly of very irregular form and are less extensive. Examples of residual deposits in the United States are the high-grade ores of the Lake Superior region and probably most of the limonitic ore of eastern Texas.

Iron deposits have probably also formed as segregations in igneous rocks by separation and concentration of magnetite and hematite during crystallization of the molten mass. Many geologic features of segregation deposits are similar to those of replacement deposits, and positive distinction between these types may be difficult. The magnetite-bearing masses at Lake Sanford, N.Y., are generally classified as segregation deposits.

PRINCIPAL IRON-ORE DEPOSITS

Descriptions of the principal sources of iron ore are included not only for general information as to the physical features of the deposits but also because geologic occurrence is the basis for inferences as to probable shape, size, position, and quality of deposits. The summation of geologic occurrences in the United States and the related interpretations indicate the probability of little or no significant change from the existing situation in which the iron-ore resources in extensive bedded deposits of the Lake Superior and southeastern regions are many times greater than those in the irregular replacement deposits that predominate in other regions.

NORTHEASTERN REGION

The principal deposits of iron ore in the northeastern region are magnetite-bearing masses of the Adirondack district in northern New York, of the highlands in northern New Jersey, and of the Cornwall mine in southeastern Pennsylvania. Most of the mining is underground, and most of the mined material requires beneficiation.

Deposits of hematite (except where associated with magnetite and mentioned below), limonite, and siderite are not of great significance in the northeastern region.

ADIRONDACK DISTRICT, NEW YORK

The most productive iron-ore deposits of the northeastern region are the magnetite bodies of the Adirondack district. These deposits are gently to steeply inclined tabular to lenticular masses whose shape and orientation conform to the structure of the enclosing Precambrian gneiss and schist. The principal deposits are at Lyon Mountain in the northeastern part of the Adirondack district, Mineville-Port Henry in the southeastern part, and the Benson mines in the western part. The main ore bodies at Lyon Mountain range in length from 700 to 4,500 feet and in thickness from 3 to 27 feet, with slope depths of as much as 2,350 feet. The Mineville-Port Henry bodies appear to be folded and faulted parts of a lens-shaped mass that was originally about 1 mile long and had an average thickness of about 100 feet. The main ore body at Benson mines is a slightly concave mass about 2 miles long, a mile wide, and about 200 feet thick; it contains both magnetite and hematite. At Lake Sanford in the southern part of the district several magnetite- and ilmenite-bearing bodies occur in gabbro and anorthosite. The largest deposit, Sanford Hill, is at least 1,800 feet long and 600 feet wide; 2 principal lenses of ore are, respectively, 800 and 1,000 feet long, 300 and 400 feet wide, and 150 and 550 feet deep. Mining at Benson mines and at Lake Sanford is by open-pit methods.

NEW JERSEY HIGHLANDS

The magnetite deposits in the highlands of northern New Jersey are moderately to steeply dipping tabular or lathlike bodies that parallel the structure of the enclosing Precambrian rocks. The ore bodies are replacements principally of gneiss but to a lesser extent of skarn and marble.

The Dover district contains the largest known magnetite deposits in the highlands. Massive ore occurs in gneiss and skarn, and disseminated ore in granite. Hematite constitutes about 15 percent of the disseminated ore. Ore bodies range from 5 to 20 feet in thickness and from 100 to 2,400 feet in breadth; several have been mined for more than 8,000 feet along the plunge.

CORNWALL DEPOSIT, PENNSYLVANIA

At Cornwall, 6 miles south of Lebanon, Pa., 2 major lenticular ore bodies of magnetite and hematite replace Cambrian limestone adjacent to intrusive diabase of Triassic age. The first one discovered was a mile long, ranged in width from a few feet to as much as 500 feet, and extended to a depth of 400 feet. This ore body dips steeply and is mined by both open-pit and underground methods; the other ore body is mined only by underground methods. Chalcopyrite containing small percentages of gold and silver, and pyrite containing 1.25 percent cobalt, are recovered as byproducts.

Magnetite of the Cornwall type is present in other localities in Pennsylvania, including the Grace mine and the Boyertown area in Berks County and an area near Dillsburg in York County.

SOUTHEASTERN REGION

Many iron-ore deposits in the southeastern region have been worked, but the Birmingham district, Alabama, ranks first in resources and production of hematite. The Russellville district, Alabama, and northwestern Georgia are the principal producers of limonite. Additional deposits of hematite, limonite, and some magnetite are common in the Appalachian area, from Maryland and the Virginias on the northeast to central Alabama on the southwest.

BIRMINGHAM DISTRICT, ALABAMA

The chief iron-ore area in the southeastern region is the Birmingham district in central Alabama, which ranks next to the Mesabi in ore reserves. The district is about 75 miles long by 40 miles wide.

The principal ore is composed of oolitic hematite that occurs in extensive bedded deposits of the Red Mountain formation, of Silurian age. Four ore beds, or seams, are interstratified with shale and sandstone. The Big Seam, which is the principal source of ore at present, crops out for about 20 miles and is relatively uniform in composition and thickness. Although the bed is 16 to 30 feet thick, only 10 to 12 feet of good ore is generally present.

The ore beds are mined by underground methods, and, because of the simple geologic structure, extensive mining is possible. The beds in the mining area dip 15°–45°. The ore contains 35 to 39 percent iron, 18 to 23 percent calcium carbonate, and 17 to 29 percent silica. Some ore is treated to reduce the silica content, but ore with a high lime content is self-fluxing and can be used as mined.

RUSSELLVILLE DISTRICT, ALABAMA

The ore of the Russellville district in northwestern Alabama consists of limonitic concentrations in various forms. The deposits are relatively small lenses or irregular masses underlying hundreds of acres, and range from a few feet to as much as 100 feet or more in thickness. Some deposits occur near the tops of hills on irregular surfaces of Bangor limestone of Mississippian age, or in the clay residue from it. Other deposits occur as fragments, cementing material, and cavity fillings in basal conglomerate and loose gravel that are generally considered to be of Tertiary age. The ore is washed to remove associated gravel and sand.

NORTHWESTERN GEORGIA DISTRICT

The most important limonitic ore deposits in northwestern Georgia are in the belt of Paleozoic strata that extends northeastward across the corner of the State. The ore occurs chiefly as irregular masses in residual clay formed from the weathering mainly of calcareous rocks and locally of quartzite. The deposits range in size from small accumulations of nodules in clay to ore bodies 50 to 150 feet or more in thickness underlying hundreds of acres. Although the host rocks of the deposits are of Cambrian and Ordovician age, the concentration into deposits of commercial ore is considered to have occurred in Tertiary time.

LAKE SUPERIOR REGION

The principal iron-ore deposits of Minnesota, Wisconsin, and Michigan are situated in long, comparatively narrow areas, called ranges, in the general vicinity of Lake Superior. The six principal iron ranges are the Vermilion, Mesabi, and Cuyuna in Minnesota, the Gogebic and Menominee in Wisconsin and Michigan, and the Marquette in Michigan.

The deposits are in iron-formation of Precambrian age. The iron-formation is bedded rock that consists of alternating iron-rich and silica-rich layers which are composed of varying proportions of iron oxide, iron carbonate, iron silicates, and chert or fine-grained quartz. The ore bodies in the iron-formation have been formed principally by oxidation of iron carbonate and iron silicate with simultaneous or subsequent leaching of silica that further concentrated the iron oxide. Ore bodies have originated also from the replacement of silica by iron and possibly from concentration of iron by normal sedimentation processes.

The Lake Superior region was previously covered by glaciers and has a discontinuous mantle of drift that is as much as several hundred feet thick. Wherever possible, the iron deposits are stripped of this glacial cover and then mined by open-pit methods. As the strata of the Mesabi range are only slightly inclined and the beds are of great horizontal extent, most of the ore is produced from open pits. Strata in the other ranges are steeply inclined, and most of the mines are underground, although in the Cuyuna range open pits predominate.

The iron ore in the Lake Superior region is mainly hematite and limonite, but some is magnetite. The iron-bearing material is classified as (a) direct-shipping ore, which can be shipped to the furnaces as mined; (b) intermediate ore, which can be beneficiated by rather simple processes; and (c) taconite—or unenriched iron-formation. Production of concentrates containing 63 to 65 percent iron from the very large tonnages of the Mesabi's magnetic taconite and from nonmagnetic iron-formation of the Marquette range is progressively increasing.

VERMILION RANGE, MINNESOTA

The Vermilion range is in northeastern Minnesota where iron-formation, which may be several hundred feet thick, underlies 2 areas of iron ore that are about 25 miles apart. These areas are approximately 5 miles long and half a mile wide. The ore is hard, dense hematite of high grade and is in lenticular to tabular bodies enclosed in steeply inclined iron-formation and interbedded greenstone of the Keewatin series (early Precambrian). Some of the large ore bodies are 1,500 feet long, and about 100 feet wide and extend downward 2,500 feet vertically. Geophysical work in 1950 indicated that an extension of the Vermilion range curves southeastward from Soudan, Minn.

MESABI RANGE, MINNESOTA

The Mesabi range, which extends for 110 miles in northeastern Minnesota, is the largest iron-ore district in the United States. The belt of iron-formation, which lies below glacial drift, averages about 1½ miles in width of exposure and 400 to 750 feet in thickness. Ore bodies range in size from a few acres to an area 3¼ miles long and one-half to 1 mile wide, and is as much as 500 feet thick. Limonite and hematite occur in approximately equal amounts.

The iron-formation in the Mesabi district is called taconite, a name that until recently has been generally restricted to this district. The taconite averages 27 percent iron, which may be present as magnetic or nonmagnetic oxide or as a silicate, and about 50 percent silica, present in the silicates and chert. Magnetic taconite is relatively lean raw material, averaging 22 percent available iron, from which a commercial product is obtained by concentration. The magnetic taconite, of which about 6,000 million long tons can be obtained by open-pit mining, has recently become an important source of iron.

CUYUNA RANGE, MINNESOTA

The Cuyuna range in central Minnesota extends about 65 miles from northeast to southwest; its width ranges from 1 to 12 miles. The district is composed of two parallel parts: the North range, which contains several belts of iron-bearing rocks and includes the main ore deposits, and the South range, which consists of a narrow iron-bearing belt that yielded a small amount of ore from 1913 to 1919 and from 1951 to 1953. The main iron-formation of the Cuyuna is 50 to 400 feet thick and is associated with slate and quartzite. All strata are complexly folded. The bedrock is covered by glacial till or drift that ranges from 20 to 400 feet in thickness; the maximum overburden in the productive area exceeds 200 feet. The ore is limonite and hematite and is generally manganiferous in the North range. Concentrates produced mainly by washing form more than half of the annual shipment of about 3 million tons. The average analysis of shipments from 1945 to 1954 was 43 percent iron and 4 percent manganese. The maximum dimensions of the ore bodies are 2 miles in length and a quarter of a mile in width. Open pits are as much as 350 feet deep, and the only underground mine is 800 feet deep.

GOGEBIC RANGE, MICHIGAN AND WISCONSIN

The Gogebic range extends about 70 miles southwestward from northwestern Michigan into northern Wisconsin. The iron-formation, which is associated with slate and quartzite, has an exposed width of 800 to 1,000 feet and a thickness of 400 to 1,000 feet. These rocks dip about 60° NW., are displaced by faults, and are intruded by dikes and sills. The ore is hematite that occurs in steeply inclined tabular bodies and plunging masses along the intersections of dikes and the iron-formation. Maximum dimensions of ore bodies are 3 miles in pitch length, 400 feet in thickness, and 1,500 feet parallel to the dip of inclined strata. At one time some ore was at the bedrock surface;

at present other masses are being mined at depths of approximately 3,500 feet. Large tonnages of low-grade ore also are present in this area.

MENOMINEE RANGE, MICHIGAN AND WISCONSIN

The Menominee range lies partly in the south-central part of the Upper Peninsula of Michigan and partly in northeastern Wisconsin. It extends northwestward in a series of disconnected segments over a distance of 50 miles and in places is 15 miles wide. In the eastern part, in southern Dickinson County, Mich., the ore is specular hematite in steeply inclined, faulted iron-formation. The iron-formation is 650 feet thick, but the middle part contains no ore. Before mining was begun, maximum dimensions of the ore, though not combined in any single ore body, were as much as 150 feet by 2,500 feet horizontally, and 2,000 feet vertically. In the western part, in southern Iron County, Mich., the ore is nonspecular hematite and limonite in complexly folded iron-formation. The iron-formation is 200 to 600 feet thick; maximum widths of ore bodies are more than 300 feet. Some ore bodies at one time extended more than 1½ miles in length and 1,000 feet in depth, others more than 2,000 feet in depth. Northern Florence County, Wis., which lies between these 2 Michigan areas, is geologically similar to Iron County and was previously mined, but it has only 1 recently active mine, a small open pit. Large tonnages of low-grade potential ore also are present in the Menominee range.

MARQUETTE RANGE, MICHIGAN

The Marquette range, which lies wholly in Michigan, extends westward from the city of Marquette for about 30 miles and is 1 to 6 miles wide. The principal iron-formation of the Marquette district attains a maximum thickness of at least 2,000 feet and lies in a westward-plunging syncline. The most productive part of the district is in the area where the exposed iron-formation crosses the axis of the fold. Tabular masses of ore parallel the stratification of the enclosing rock, cylindrical ones occur along intersections of dikes, and irregular ones rest on sills. Ore bodies, which are as much as 250 feet thick, have been mined to vertical depths of almost 3,000 feet. The ore produced is principally hematite, part of which is premium lump material for use in open-hearth furnaces. The range also contains large tonnages of oxidized iron-formation, known as jaspilite, which is a potential source of iron. Production of concentrates from some of this material began in 1954.

Another iron-formation is as much as 200 feet thick and has been mined along the north side of the basin in the western part of the range. The ore bodies are relatively small, shallow, and irregular. Beneficiation of low-grade ore from this formation began in 1952.

CENTRAL AND GULF REGION

Iron-ore reserves in the central and gulf region are generally smaller than in the other regions. The largest deposits are limonite and siderite ores of the eastern Texas district and specular hematite of Iron Mountain in southeastern Missouri.

EASTERN TEXAS DISTRICT

Surficial deposits of limonite or brown ore occur over a wide area in eastern and northeastern Texas. Below the weathered zone the limonite grades into siderite, which is also plentiful. The deposits are almost exclusively in greensand (a mixture of glauconitic sand, quartz sand, and clay) that averages about 25 feet in thickness and is of early Tertiary age. The ore occurs in gently dipping strata on flat-topped hills and ridges where thin ferruginous sandstone cappings have protected the underlying material from erosion. The ore is believed to have been derived from iron silicate minerals in greensand, first by alteration to siderite and subsequently by oxidation and hydration to limonite.

The ore beds lie within a shallow structural trough that is divided into North and South basins. The brown ore in the North basin occurs chiefly as abundant nodules and thin lenticular layers in a zone 5 to 30 feet thick in the upper part of the greensand. Siderite, which forms about one-third of the ore in the North basin, is present in similar forms at or near the ground-water level. Most of the workable ore-bearing material underlies areas of several hundred acres, and the largest deposit underlies at least 2,500 acres.

The ore in the South basin occurs almost continuously for many miles along the outcrop as a solid bed of brown laminated or crumbly material which ranges in thickness from a few inches to 3 or 4 feet. The horizontal subsurface extent of the ore is limited to approximately 500 feet from the outcrop. In this basin the rock was formerly glauconitic clay with little or no quartz sand. Siderite is far less plentiful here than in the North basin.

Limonitic and carbonate ores, which are mined by open-pit methods, are washed to remove the sand and gravel. Some of the limonitic ore is dried in kilns after washing, and the carbonate ore, in addition to being dried, is calcined and sintered.

IRON MOUNTAIN DEPOSITS, MISSOURI

The deposits at Iron Mountain, in southeastern Missouri, contain the principal iron ore in the State. The ore is chiefly massive hard specular hematite, which forms replacement masses and veins in andesite porphyry of Precambrian age.

One ore body at this locality is a vein several hundred feet long and as much as 200 feet wide. A second body is a roughly ellipsoidal, dome-shaped mass about 60 feet thick and about 500 by 1,000 feet across. A third ore body may be dome shaped, with a diameter of about 400 feet and a thickness of 40 feet. The ore is mined by open-pit and underground methods and must be beneficiated to produce a marketable product.

WESTERN REGION

In the western region, magnetite occurrences outnumber those of hematite and limonite, but hematite forms the largest deposits and is the most important iron-ore mineral. The deposits of magnetite and hematite are predominantly replacements of limestone or dolomite. The principal iron-ore deposits in this region are in the Iron Springs district, about 10 miles west of Cedar City, Iron County, southwestern Utah; in the Eagle Mountains, northern Riverside County, southern California; and in the Hartville district, Platte County, southeastern Wyoming. Other iron-ore deposits in this region are relatively small and widely scattered.

IRON SPRINGS DISTRICT, UTAH

The Iron Springs district covers an area of about 60 square miles. The ore bodies are lens- and wedge-shaped replacements of limestone of Jurassic age encircling 3 oval quartz monzonite intrusions of early Tertiary age which have areas of approximately 5, 10, and 15 square miles. Mixed hematite and magnetite masses are as much as 250 feet thick and extend from a few hundred feet to more than 1,000 feet along the strike and down the dip.

EAGLE MOUNTAINS DEPOSITS, CALIFORNIA

The Eagle Mountains deposits, the most important of the many and widely distributed iron deposits in California, occur in an area 6 miles long and 1½ to 2 miles wide. Replacements of metamorphosed limestone or dolomite by magnetite and hematite are closely associated with intrusive quartz monzonite of Precambrian to Tertiary age. Iron ore occurs discontinuously for more than 8,000 feet along the strike of 2 faulted beds which are 80 feet thick and 30 to 300 feet thick and dip 20°–60°. The major ore bodies are 600 to 1,500 feet long and 70 to 300 feet thick, and they extend 200 to 750 feet down the dip.

HARTVILLE DISTRICT, WYOMING

The most important iron-ore deposits of the Hartville district, Wyoming, are irregular lenses of high-grade soft and hard hematite of sedimentary or replacement origin in Precambrian schist. Some of the ore bodies are more than 1,000 feet long and range from a few feet to about 100 feet in width; one has been reported to have a maximum thickness of 900 feet.

ALASKA

Iron deposits are known to occur at a number of localities in Alaska (pl. 2), and although discovery of other deposits can be expected, the area appears unfavorable for deposits of major size.

PRINCE OF WALES ISLAND

The principal iron deposits of Alaska, which occur in the Kasaan Peninsula of Prince of Wales Island, are replacement masses of magnetite in a folded and faulted part of a sequence of volcanic rocks. Accessory amounts of the copper-bearing mineral, chalcopyrite, are present and locally were sufficiently abundant to have been mined from 1905 to 1918 in the Mount Andrew-Mamie area; minor amounts of gold and silver were also recovered.

The largest iron deposits in the Kasaan Peninsula are in the Mount Andrew-Mamie area, mainly in two gently inclined bodies along the bottom of folds. The ore body at the Mount Andrew mine is a compound mass of numerous contorted layers of magnetite and an approximately equal amount of interlayered rock; it is 600 feet long and 550 feet wide, and extends to a depth of 100 to 150 feet. The deposit at the Mamie mine is at least 400 feet long, 15 to 50 feet thick, and is known to a depth of 400 feet and probably does not extend much deeper.

Deposits in other parts of the Kasaan Peninsula are steeply inclined masses along fracture zones. The main reserve is in the Poor Man deposit, which is 1,500 feet long and 15 to 150 feet wide and is estimated to extend to a depth of at least 200 feet.

Lenses of magnetite in Jumbo basin (pl. 2) are believed to be replacements of marble. The principal lens is 300 feet long and as much as 60 feet thick and extends for more than 400 feet at an inclination of 60°. A few much smaller lenses are present.

HAINES-KLUKWAN

At Haines-Klukwan, altered volcanic rocks over an area of about 2 square miles average about 13 percent iron recoverable as magnetite-ilmenite that is found in disseminated form and in anastomosing masses or veins. The rock in a zone about 2 miles long and 500 feet wide averages about 20 percent iron. An alluvial fan at Klukwan is believed to average about 10 percent magnetic iron over an area of about 4 square miles, with a maximum thickness of about 700 feet. Milling tests by the U.S. Bureau of Mines indicate that concentrates containing about 60 percent Fe and 2 to 4 percent TiO_2 can be obtained with a concentration ratio of about 10 : 1.

SNETTISHAM

Iron deposits at Snettisham are similar to those at Haines and underlie an area approximately 8,000 feet long and 2,000 feet wide. The average crude ore contains about 12 percent magnetic iron, and concentration to 20 percent of the original sample volume is required for assays of 60 percent iron.

PUERTO RICO

MAYAGÜEZ MESA

The largest iron-ore resources of Puerto Rico are of lateritic material and are at Mayagüez Mesa in the western part of the island (pl. 2). The limonitic residue underlies an area about 3 miles long by half a mile wide and ranges from 15 to 30 feet in thickness. The value of this material is limited because the amounts of alumina, nickel, and chromium in the ore would probably cause problems in smelting. Also, recent building in the western end of the area would probably preclude mining of a large section of the ore.

JUNCOS

The ore body at Juncos is of the replacement type and is typical of the few small iron deposits in the central and eastern parts of the island. The masses, consisting of magnetite and hematite, are 200 to 1,800 feet long and 12 to 80 feet wide.

MINING AND BENEFICIATION

RELATION OF MINING TO GEOLOGY

The methods by which iron ore is mined are determined by the location, size, shape, and character of the ore body, and by the nature of the enclosing rock. Open-pit operations are used wherever possible for mining mineral deposits having considerable horizontal extent. A few of the many examples of this type of mining made possible by favorable geologic conditions are in the Mesabi district of Minnesota, the Russellville district in Alabama, the deposits at Benson mines and Lake Sanford in the Adirondack district of New York, the Iron Springs district in Utah, and the Eagle Mountains deposits in California.

Underground methods are used to mine deposits where excessive waste rock would have to be removed to obtain the ore by open-pit operations. These deposits generally are steeply inclined or vertical, except in the Birmingham district of Alabama and the Mesabi district of Minnesota. They extend to depths of from 100 feet to more than 3,000 feet and may or may not be exposed at the surface. The deposits range in form from generally tabular to roughly cylindrical, and methods of mining must be adapted accordingly. Underground mining is necessary in most of the iron-ore mines in the northeastern region, in the Birmingham district, in the Lake Superior region except for most of the Mesabi and Cuyuna districts, in Missouri, and in Wyoming.

TYPES OF COMMERCIAL ORE

For commercial purposes, iron ore is classified according to chemical composition and physical character. If impurities are not in excessive amounts, the iron content of the ore is of foremost importance. The percentage differs, however, with mineralogic type of material and source as shown in table 2. If the material as mined meets market specifications for composition, it is classed as direct-shipping ore—that is, it requires no treatment before smelting. The suitability of iron ore for various steel-making processes is limited by its phosphorus content. Ore that has a content of less than 0.045 percent phosphorus to 50 percent iron is classed as bessemer ore, and after smelting can be rapidly made into steel by bessemer converters. Nonbessemer ore may contain as much as 0.18 percent phosphorus, and high-phosphorus ore has more than 0.18 percent; steel from these two types of ores is made in open-hearth furnaces.

The physical character of iron ore is the basis of a twofold classification. Lump or hard ore is very compact and coherent material; soft ore is porous, granular, and earthy to only moderately coherent. Lump ore is especially desirable for use in open-hearth furnaces. Each type of material is produced exclusively or predominantly by some mines, but more commonly the types occur together and are not mined separately.

METHODS AND PRODUCTS OF BENEFICIATION

Iron-bearing material that does not qualify as direct-shipping ore may be beneficiated to make a marketable product. Beneficiation, which is becoming increasingly important, is accomplished by several processes depending upon the type of ore.

CHANGE IN CHEMICAL COMPOSITION

Beneficiation related to chemical composition is accomplished by adequate separation of iron-bearing and iron-free constituents present in the untreated material (crude ore) so that the percentages of iron and other elements in the product meet specifications.

Crude ore may be heated in kilns to drive off excessive moisture or to remove carbon dioxide from sideritic ore and produce much higher grade iron oxides.

More common processes of beneficiation depend upon differences in specific gravity to separate heavy ore minerals from lighter value-less gangue minerals. Concentration by relative buoyancy is achieved through the use of water in a variety of washing arrangements or the use of circulating heavy media. Centrifugal force produces concentration in Humphrey spirals and cyclone separators.

Flotation is a method of beneficiation in which certain minerals are caused to adhere to bubbles and float at the surface of a liquid while other minerals remain submerged, thus effecting a separation between ore and waste material.

Magnetic separation is commonly used to upgrade crude magnetite-bearing ore.

CHANGE IN PHYSICAL CONDITION

Fine-grained ores and concentrates are subject to excessive losses in shipment and are not suitable for direct use in common smelting operations, but these fine-grained materials can be converted into marketable products by agglomeration to sinter, nodules, pellets, or briquets. Sintering forms porous, somewhat clinkerlike masses by combustion in a layer of ore mixed with fine particles of coal or coke. Nodulizing produces spherical masses about 4 to 5 inches in diameter by the heating of a mixture of fine-grained ore or concentrate and suitable binding material in an inclined rotary kiln. Pelletizing produces spherical masses about one-half inch in diameter by mixing fine-grained concentrates with binding material and, sometimes, solid fuel, and passing the mixture through balling drums to form pellets that are partially sintered in a shaft furnace or on a moving hearth.

TACONITE BENEFICIATION

Developments in the utilization of magnetic taconite in the eastern part of the Mesabi district are especially significant because of their magnitude. Magnetic separation and subsequent pelletizing have been sufficiently successful that one plant, with an annual capacity of nearly 4 million tons of concentrates, was put into operation in March 1956, and another plant, with an annual capacity of 7.5 million tons of concentrates, was completed in late 1957. The magnetic taconite contains about 22 percent iron in the form of magnetite, but concentration of 3 tons of crude ore into 1 ton of pellets increases the iron content to 64 percent. The greater costs of beneficiating magnetic taconite as compared to production of direct-shipping ore is mainly or entirely offset by savings in shipping charges and in operation of blast furnaces. It has been estimated (Gruner, 1954) that 6,000 million tons of magnetic taconite is available for open-pit mining and is amenable to present methods of beneficiation; the amount of resulting concentrates should be about 2,000 million tons, which would equal the total production of the Mesabi district from the beginning of production in 1892 through 1955. The success of taconite beneficiation assures that the Lake Superior region will probably continue to be the most important source of iron ore, and that it may have an even more predominant position in the future; the importance of this development may be comparable to the original discovery of the Mesabi district.

IRON-ORE RESERVES AND POTENTIAL ORE

CLASSIFICATION AND TERMINOLOGY

The terms "reserves," "potential ore," and "resources" as used in this report follow the concepts of Blondel and Lasky (1955, p. 173):

> . . . we suggest classifying mineral masses into at least two broad categories: (1) those considered exploitable for usable material under existing economic and local conditions—reserves; and (2) those, which to be exploited for usable material, demand more favourable conditions than the existing ones—potential ores. . . . The term "resources" would, in that case, be used to designate the total of reserves plus potential ores.

Potential ore thus includes (a) material of lower iron content than that which is now being mined, (b) material of usable grade in deposits of less than minable size, (c) deposits of minable size which contain excessive quantities of impurities, and (d) deposits technologically satisfactory but too remote from transportation and blast furnaces for present use. Nevertheless, some deposits that have unfavorable features may be mined under emergency conditions.

FACTORS IN RESOURCE APPRAISAL

Estimates of iron-ore reserves and potential ore in a deposit or group of deposits include evaluation of many uncertain and variable factors related to the grade, dimensions, and geologic occurrence of the ore bodies. Data obtained from test pits, trenches, exploratory shafts, and drilling are the basis for most estimates of the grade of ore and the dimensions of an ore body, but these exploratory operations may provide sufficient information on only part of the total deposit that may be ultimately suitable for development. Concepts concerning the occurrence and origin of the deposit will then in turn have an important influence on interpolation and extrapolation relative to estimating the tonnage and grade of the deposit as a whole. The reliability of reserve estimates is dependent, therefore, upon both the geologic data available and the validity of the interpretations used in computing the tonnage.

The estimated reserves of a mineral commodity are commonly expressed as tonnage and grade, or metal content, but with an implied qualification that mining, milling, smelting, and selling of products from the material probably will yield a satisfactory remuneration. The primary purpose of estimating reserves of a mineral commodity is to determine the value of the deposits and to plan intelligently and effectively for their exploitation. Not only must the methods and facilities for mining, milling, and smelting be planned, but the tonnage and grade of the reserve should be sufficiently well established to provide adequate assurance for the amortization of the capital expenditures and for some profit. The estimated reserves are an indication of that assurance, but they are not generally a prediction of the total amount of ore that can be produced from a deposit or district. The uncertainty of this proportional relation between estimated reserves and total available ore may therefore lead to false predictions and conclusions if based only upon the oversimplified equation of estimated reserves, divided by annual production. Estimates of reserves as a whole must be considered transitory, because they are continually being affected by discovery of new deposits, development, production, and especially by advances in mineral-industry technology. Furthermore, estimates of iron-ore reserves may increase as the physical and technical problems involved in utilization of potential ore become solved and the material is reclassified as reserves.

Reserves in an inventory sense are composed of material that probably can be profitably exploited within a reasonable period; profitable exploitation is dependent upon the differential between cost and selling price, and a reasonable period is determined by plans of the mining company. Both of these factors are in part influenced by taxation. Thus, in another respect, the estimated reserves are only a part of the total available supply, because the amount that is estimated to be minable at any specified time is determined by existing or expected economic and technologic conditions. It is evident from the foregoing that figures for reserves are only approximate.

TABULATION OF IRON-ORE RESOURCES

The tabulations of iron-ore resources (tables 3, 4, and 5) are the synthesis of many published and unpublished data, most of which are based on fieldwork by the U.S. Geological Survey. The compilation would not have been possible, however, without the cordial cooperation of the State geologists and other officials of the States involved, the U.S. Bureau of Mines, and many individuals who furnished information not otherwise available.

The total domestic iron-ore resources in continental United States are estimated to be approximately 75,000 million long tons of crude ore. Table 3 summarizes the detailed data and shows that iron-ore reserves (direct-shipping ore and concentrates by present methods) are estimated to be about 5,500 million long tons (obtained from about 10,000 million tons of reserves of crude ore), and potential ores are estimated to be about 65,000 million long tons. The potential ore may yield 25,000 million long tons of concentrates and some direct-shipping ore. Alaska has approximately 5 million tons of iron-ore reserves; Puerto Rico has small reserves. Both Alaska and Puerto Rico are estimated to have large amounts of potential ore. Table 4 lists individual iron-ore areas and deposits that are estimated to contain at least 200,000 long tons each of reserves or potential ore, arranged by regions of continental United States and alphabetically by States within the regions. Data on iron deposits of Alaska and Puerto Rico are given in table 5. The estimates are in terms of crude ore except as otherwise indicated. Most published figures for reserves that are shown in the tables have not been corrected for depletion due to subsequent mining, because continuing exploration may increase the known reserves at a rate equal to or exceeding that of extraction. Table 6 is a finding list for iron deposits shown on pl. 2 and in tables 4 and 5.

For some areas and deposits listed in the tables and shown on the map (pl. 2), only unpublished estimates of reserves and potential resources are available and no references can be given; for others, data are only general estimates from published reports. The magnitude of such estimates is indicated by the designations "small" (less than 2 million long tons), "moderate" (2 million to 10 million long tons), and "large" (more than 10 million long tons).

Those States that have no known iron deposits of 200,000 long tons or more have been omitted from the tabulation. However, references to publications on some deposits that may be of importance in the future, including deposits in States not included in the tabulation, are cited in the geographic index to the selected bibliography (p. 127) under the specific region in which the State is included.

The estimates in the resource tabulations (tables 3, 4, and 5) are classed as measured, indicated, and inferred, according to Geological Survey and Bureau of Mines usage:

Measured ore designates tonnage for which size, shape, and mineral content are well established.

Indicated ore is used for tonnage computed partly from specific measurements and partly from projection for a reasonable distance on geologic evidence.

Inferred ore is tonnage for which quantitative estimates are based upon broad knowledge of the geologic character and relations of the deposit and for which there are few, if any, samples or measurements.

The iron-ore resources that are believed to be the most important in the United States are marked by an asterisk (*). The areas or deposits are numbered by States as on plate 2.

All grades are given in terms of natural (undried) material, unless otherwise stated. In some instances the grades have been revised to agree with more recent information than that given in the references cited.

TABLE 3.—*Summary of iron-ore resources of the United States, Alaska, and Puerto Rico*

Region and type of reserves or potential ore	Reserves					Potential ore	
	Iron content (percent)		Estimated tonnage (millions of long tons) of direct-shipping ore and concentrates			Approximate iron content (percent)	Estimated tonnage (millions of long tons)
	Range (approx.)	Shipping grade (approx.)	Measured and indicated	Inferred	Total		
UNITED STATES, BY REGIONS							
Northeastern:							
Concentrates		58–63	100	200	300		
Crude ore	25–45					43	1,230
Do						27	1,620
Total			100	200	300		2,850
Southeastern:							
Direct-shipping ore	31–53	36	275	275	550		
Concentrates		50	45	15	60		
Crude ore	25–50					50	[1] 110
Do						37	[1] 610
Do						31	10,500
Total			320	290	610		[1] 11,220
Lake Superior:							
Direct-shipping and intermediate crude ore	43–56	50	1,450	550	2,000		
Magnetic concentrates [2]		63	800	1,200	2,000		
Crude ore [3]	[4] 11–45					25–45	35,000
Do						[4] 22	15,000
Total			2,250	1,750	4,000		50,000
Central and gulf:							
Concentrates		48	[5] 25	[5] 25	50		
Crude ore	40–50					50	3
Do						40	[1] 113
Total			[5] 25	[5] 25	50		[1] 116
Western:							
Direct-shipping ore	30–55	50	180	310	490		
Crude ore						50	[1] 210
Do						40	[1] 290
Total			180	310	490		[1] 500
Grand total			2,875	2,575	[6] 5,450		[1,7] 64,686
ALASKA							
Crude ore	45–52				5	10–50	Large
PUERTO RICO							
Crude ore		60		Small	Small	40	Large

[1] Conservative estimate.
[2] From magnetic taconite of the Mesabi range.
[3] Taconite of the Mesabi range and similar low-grade iron-formation of other ranges.
[4] Magnetic taconite of the Mesabi range contains 11 to 34 percent iron that is recoverable magnetically; the average is 22 percent.
[5] Mostly a preliminary estimate of Texas ore by Perkins and Lonsdale (1955).
[6] Obtained from about 10,000 million long tons of reserves of crude ore.
[7] Equivalent to about 25,000 million long tons of concentrates plus a little direct-shipping ore.

TABLE 4.—*Iron-ore resources of areas or deposits in the United States, by regions and States*

[Resources of greatest national importance are indicated by asterisk (*)]

Locality No. (pl. 2)	Area or deposit (alternate name in parentheses)	Types of ore (in order of abundance)	Approximate iron content (percent)	Estimated resources of crude ore (millions of long tons): Reserves and potential ore: Measured	Indicated	Inferred	Potential ore, unclassified	Reference
	NORTHEASTERN REGION							
	Maine							
1	Aroostook County, Central district.	Hematite and magnetite	21	----	----	----	[1] 256	Eilertsen (1952, p. 16).
2	Aroostook County, Northern district.	Hematite	} 18	----	----	----	[1] Large	Miller (1947, p. 1, 2, 38–39).
3	Aroostook County, Southern district.	Magnetite, hematite, and manganiferous siderite.						
	New Jersey							
1	Dover district	Magnetite	[2] 40–60	----	----	----	----	Sims (1953, p. 246).
	Do	do	----	*[3] Moderate	*[3] Large	*[4] Large	[5] Large	
2	Ogden mines	do	[6] 19–27	----	Moderate	Large	Large	
3	Oxford mines	do	[7] 42–50	----	----	Moderate	----	
4	Ringwood district	do	[8] 35–60	Small	Small	Moderate	Moderate	
	New York							
1	Arnold Hill, Ausable Forks area.	Magnetite	25–27	----	----	Large	Large	
2	Benson mines	Magnetite and hematite	25	----	----	----	----	Mining World (1953, p. 41).
	Do	do	----	*103	----	*Large	Large	Tillinghast (1948, p. 28).
3	Croton mine, Brewster belt	Magnetite	24–30	Moderate	Moderate	Moderate		
4	Fishkill-Clove	Limonite	40–50	Small	----	----	----	
5	Forest of Dean group	Magnetite	56	----	----	Small	----	
6	Hammondville-Crown Point	do	36	----	----	Small	----	
7	Harlem Valley	Limonite	43	Small	----	----	----	
8	Lake Sanford	Titaniferous magnetite	27	*15	*11	*12	----	Balsley (1943, p. 122).
	Do	do	----	*50		*50	----	American Metal Market (1955, p. 1).

9	Lyon Mountain belt	Magnetite	25–30	*Large	*Large	*Large		
10	Mineville-Port Henry	do	42	*Large			Large	
11	Saranac Valley	do	23				Moderate	
12	Southeastern St. Lawrence County, except Benson mines.	do	24–42	Moderate	15	50	80	
13	Sterling belt	Hematite	40			Small		
14	Sterling Lake	Magnetite	40–45	Small	Small	Moderate	Large	
15	West-central New York	Hematite	35–45				600	Newland and Hartnagle (1908, p. 6, 44).
	Ohio							
1	Southeastern Ohio	Siderite	29–35				500	Bengston and others (1950, p. 88, 91).
2	Tuscarawas County and adjacent areas.	do	26–34				260	Ireland (1944, p. 1054, 1056).
	Pennsylvania							
1	Boyertown	Magnetite	33–43			Moderate		
	Do	do		1				Pennsylvania Department of Internal Affairs and The Pennsylvania State College (1944, p. 134).
2	Central Pennsylvania, limonite area, other than Scotia.	Limonite		0.6				Julihn and Moon (1945, p. 13)
	Do	do	45–47			Large		
3	Central Pennsylvania, hematite area.	Hematite	20–50		5		50	Hayes (1909, p. 88, 90).
4	Cornwall	Magnetite	42					Shale (1953, p. 670).
	Do	do		*Large				Hart (1939, p. 6).
5	Dillsburg	do	35		Small	Moderate		
6	Grace mine	do	44					Knoerr (1953, p. 90).
	Do	do			*Large			
7	Rittenhouse Gap	do	23		Small		Small	
8	Scotia	Limonite	[9] 41–53	1.7	0.7	1.7		Julihn and Moon (1945, p. 13), Butts and Moore (1936, p. 97).
9	Vera Cruz	Magnetite	42				20	B. L. Miller (1941, p. 319).
10	Western Pennsylvania	Siderite	30–35				46	Hayes (1909, p. 94–95).
11	White Rocks	Limonite [10]	45		1.8			Foose (1945, p. 24, 35).
	Rhode Island							
1	Iron Mine Hill	Titaniferous magnetite	33				[11] Moderate	

See footnotes at end of table, p. 100–101.

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TABLE 4.—*Iron-ore resources of areas or deposits in the United States, by regions and States*—Continued

Locality No. (pl. 2)	Area or deposit (alternate name in parentheses)	Types of ore (in order of abundance)	Approximate iron content (percent)	Estimated resources of crude ore (millions of long tons)				Reference
				Reserves and potential ore			Potential ore, unclassified	
				Measured	Indicated	Inferred		
SOUTHEASTERN REGION								
Alabama								
1	Birmingham	Hematite	39	*[12,13] 280		*[12,13] 268		Thoenen, Reed, and Clemmons (1953, p. 13, 17).
	Do	do	35		*[13,14] 580			Do.
	Do	do	25–37				Several thousand million.[15]	
2	Eastern Alabama	Limonite	[9] 47–52					Burchard (1938, p. 184).
	Do	do		[16] 4.5		[16] 1.5	[16] 5	
3	Greasy Cove	Hematite	30–35		7.5			Burchard and Andrews (1947, p. 103).
4	Greens Creek-Colvin Mountain.	do	30–38	0.81				Burchard and Andrews (1947, p. 2, 368).
5	Lookout Mountain plateau	do					[17] 2,500	Burchard and Andrews (1947, p. 367).
	Do	do	27–35					Burchard (1909, p. 183, 187).
6	Murphree's Valley	do	30–38	1.7				Burchard and Andrews (1947, p. 2, 264).
7	Russellville	Limonite	[9] 51–57		*12		6.8	Pallister and Burchard (1953, p. 48, 50).
8	Shinbone Ridge	Hematite	30–40	7.8				Burchard (1909, p. 183); Burchard and Andrews (1947, p. 230).
	Do	do	25–35				32	Burchard (1909, p. 187).
9	Southern Alabama	Limonite	[9] 45–55	1.7				Pallister and Burchard (1953, p. 50), Burchard (1938, p. 184).
	Do	do				[16] 1	[16] 0.5	
10	Springville-Whitney	Hematite	30–40	8.5				Burchard and Andrews (1947, p. 271–274).
11	Talladega	Gray or specular hematite and magnetite.	34		22		22	Julihn and Moon (1945, p. 10); Pallister and Burchard (1953, p. 50).

12	Wills Valley, northwestern side	Hematite	28-33	2.5				Burchard and Andrews (1947, p. 206).
13	Wills Valley, southeastern side	do	25-30	31				Burchard (1909, p. 187); Burchard and Andrews (1947, p. 160).
	Do	do	25-30				280	Burchard (1909, p. 187).
14	Woodstock	Limonite	[9] 40-50	1.3			1.3	Pallister and Burchard (1953, p. 48, 50).
15	Woodstock-Bucksville	Hematite	48		4.5	6.7		Reed (1953, p. 1).
	Do	do	36			7.2		Do.
				Georgia				
1	Broncho	Hematite	25-30			3		Burchard (1909, p 187).
2	Cartersville	do	52				Moderate	Kesler (1950, p. 89, 95).
3	Cenchatt	do	25-32			1		Burchard (1909, p. 187).
4	Copeland	do	20-32			8		Do.
5	Dirtseller Mountain (Collyarton).	do	25-30	3				Burchard (1909, p. 182, 187).
6	Eagle Cliff	do	25-33			4		Burchard (1909, p. 187).
7	Estelle	do	28-35	13		25		Do.
8	Lookout Mountain area	do	27-35				[18] 1,300	Pallister and Burchard (1953, p. 183, 187).
9	New England-Wildwood	do	22-30			13		Burchard (1909, p. 187).
10	Northwestern Georgia	Limonite	[9] 47-52	*22.4		*6.7		Pallister and Burchard (1953 p. 50); McCallie (1900, p. 33-161).
	Do	do					[16] 9	
11	Pudding Ridge	Hematite	20-33			0.85		Burchard (1909, p. 187).
12	Rising Fawn	do	20-30	2.5		10		Do.
13	Taylor Ridge	do	20-30			1.8		Do.
				Kentucky				
1	Northeastern Kentucky, Appalachian region. (1a, Hanging Rock area; 1b, Slate Creek area).	Siderite	30-35 (1943-47)				60	Hayes (1909, p. 94-95).
2	Rose Run area	Hematite	32			1.1		Julihn and Moon (1945, p. 10).
3	Trigg, Lyon, Livingston, and Crittenden Counties.	Limonite	32					
	Do	do					Small	Nelson and Wood (1949, p. 6).

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TABLE 4.—*Iron-ore resources of areas or deposits in the United States, by regions and States*—Continued

Locality No. (pl. 2)	Area or deposit (alternate name in parentheses)	Types of ore (in order of abundance)	Approximate iron content (percent)	Estimated resources of crude ore (millions of long tons)				Reference
				Reserves and potential ore			Potential ore, unclassified	
				Measured	Indicated	Inferred		
SOUTHEASTERN REGION—Continued								
Maryland								
1	Alleghany and Garrett Counties.	Siderite	35					Singewald (1911, p. 236–237).
2	Catoctin Mountain	Limonite	37–43			Small		Singewald (1911, p 195, 199).
3	Do	Magnetite	35				Small	Singewald (1911, p. 314).
4	Chestnut Hill ore banks	Limonite	48–50				Large	Singewald (1911, p. 210–212).
5	Coastal Plain	Siderite [20]	34					Singewald (1911, p. 256).
6	Evitts and Tussey Mountains:							
	Upper bed	Hematite	37				[11] 0.3	Singewald (1911, p. 296, 300).
	Lower bed	do	23–25				[11] 3.1	Singewald (1911, p. 298, 301).
7	Springfield mine	Specular hematite	[21] 40			Small		
8	Tolley ore bank	Limonite	54				Small	Singewald (1911, p. 227).
9	Wills Mountain:							
	Upper bed	Hematite	37				[11] 0.89	Singewald (1911, p. 296, 300).
	Lower bed	do	23-25				[11] 21	Singewald (1911, p. 298, 301).
Mississippi								
1	Lafayette County	Limonite, some hematite and siderite.	40–55		6.4			Attaya (1952, p. 24).
2	Marshall County, southeastern part.	do	[20] 45–54		10			Vestal (1954, p. 170–171, 174).
3	Webster County and borders of Montgomery and Choctaw Counties.	do	40–55		16			Vestal (1951, p. 46).

	North Carolina							
1	Ballou belt	Nontitaniferous and titaniferous magnetite.	46			0.6		Bayley (1922, p. 218); Bayley (1923, p. 160).
2	Big ore bank	Magnetite	29	0.63				Julihn and Moon (1945, p. 13).
3	Cranberry	do	20–25		Small			
4	Knap of Reeds (Camp Butner).	Hematite and magnetite	36–50			Small		
5	Valley River belt	Limonite	[22] 41–58		4			Bayley (1925, p. 18–48).
	Tennessee							
1	Chamberlain-Barnardsville	Hematite	50	0.02				Julihn and Moon (1945, p. 13).
	Do	do	25		11		Large	Do.
2	Cumberland Plateau	do	27–35				[23] 211	
3	Eastern Tennessee	Limonite		[16] 1.3		[16] 1.2	[16] 0.5	
4	Euchee	Hematite	26–32	3.5				Burchard (1909, p. 187).
5	Glen Alice	do	30–40	2.5		7.5		Do.
6	Inman	do	25			8.9		Burchard (1909, p. 177, 187).
7	North Chattanooga	do	30			0.4		Do.
8	Northeastern Tennessee, including LaFollette area.	do	26–32				1,255	Burchard (1913, p. 144); Burchard (1914, p. 303).
	Do	do		[16] 7.2				
9	Ooltewah	do	30–50			0.5		Burchard (1909, p. 187).
10	Rockwood-Cardiff	do	33–40	15		40		Do.
11	Western Highland Rim	Limonite	[9] 38–52		11		5.8	Pallister and Burchard (1953, p. 50); Burchard (1934, p. 27).
	Virginia							
1	Alleghany County and vicinity.	Limonite and hematite	25–30			5	Large	Julihn and Moon (1945, p. 14).
2	Blue Ridge	Hematite	35–40					Gooch (1954, p. 4).
	Do	do				Large		
3	Carroll-Grayson district	Titaniferous magnetite	50					Gooch (1954, p. 5).
4	Gossan Lead	Limonite	35–45					Gooch (1954, p. 4).
	Do	do			Small			
5	Lee-Wise district	Hematite	40				Small	Do.
6	Pulaski-Smyth district	Limonite	40–45					Gooch (1954, p. 3).

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TABLE 4.—*Iron-ore resources of areas or deposits in the United States, by regions and States*—Continued

Locality No. (pl. 2)	Area or deposit (alternate name in parentheses)	Types of ore (in order of abundance)	Approximate iron content (percent)	Estimated resources of crude ore (millions of long tons): Reserves and potential ore				Reference
				Measured	Indicated	Inferred	Potential ore, unclassified	
	SOUTHEASTERN REGION—Continued							
	West Virginia							
	[Areas in West Virginia other than those listed in the table contain potential iron-ore deposits. These are discussed in the State Geological Survey county reports]							
1	Central West Virginia	Siderite						
2	Greenbrier and Pocahontas Counties.	Limonite	52–63			[24] 1.6	Large	Julihn and Moon (1945, p. 14); Grimsley (1909, p. 272, 274); Reeves (1942, p. 21, 39).
3	South Fork Mountain	Hematite	50–55				Large	Grimsley (1909, p. 169, 280).
	LAKE SUPERIOR REGION							
	Michigan							
1	Gogebic range	Hematite	52	*31	*[25] 70			Dutton (1955, p. 191); Roberts and Crago (1948, p. 2); Wade and Alm (1954, p. 239).
	Do	do	25–45				[26] 2,750	
2	Marquette range	do	51	*65	*[25] 185			Do.
	Do	do	25–45				[26] 17,500	
3	Menominee range	Hematite and limonite	50	*62	*[25] 75			Do.
	Iron County	Hematite, limonite, and siderite.	25–45				[26] 3,000	
	Dickinson County	Hematite	25–45				[26] 1,320	
	Minnesota							
1	Cuyuna range	Limonite and hematite.[27]	43	*46	*[25] 50		[26] 4,400	Roberts and Crago (1948, p. 2); Wade and Alm (1954, p. 238, 241).
2	Fillmore County	Limonite	48	0.65				Wade and Alm (1954, p. 238, 241).
3	Mesabi range	Limonite and hematite	50	*855	*[25] 500			Roberts and Crago (1948, p. 2); Wade and Alm (1954, p. 238, 241).

	Do	Magnetite (taconite)	22		*[28] 5,000–6,000		[26] [29] 15,000	Gruner (1954, p. 287–288).
4	Vermilion range	Hematite	56	*13	*[25] 25		[26] 330	Roberts and Crago (1948, p. 2); Wade and Alm (1954, p. 238, 241).
	Do	do	35				Large	Van Hise and Leith (1911, p. 492).
	Wisconsin							
1	Baraboo range	Hematite	35				[30] Large	Van Hise and Leith (1911, p. 492).
2	Black River Falls	Magnetite and hematite	30				Large	
3	Gogebic range	Hematite	52	*6.5	*[25] 30			Roberts and Crago (1948, p. 2); Wade and Alm (1954, p. 239).
	Do	Hematite and magnetite	25–35				[26] 5,000	Zinner and Holmberg (1947, p. 10–13).
4	Menominee range, Florence area.	Hematite and limonite	35				[31] Large	Van Hise and Leith (1911, p. 492).
5	Mayville-Iron Ridge district	Hematite	45				Large	Van Hise and Leith (1911, p. 567).
	Do	do	40	Moderate				
	CENTRAL AND GULF REGION							
	Arkansas							
1	Magnet Cove	Titaniferous magnetite	50–56			Small		
2	Northeastern Arkansas [24]	Limonite	24–59					Penrose (1892, p. 22).
	Iowa							
1	Waukon	Limonite	37			0.5		Julihn and Moon (1945, p. 10).
	Missouri							
1	Bourbon-Sullivan	Magnetite and hematite	44					McMillan (1946, p. 1).
2	Central Missouri [33]	Limonite	42–55		0.3			
3	Iron Mountain [32]	Specular hematite	[33] 50		*10			
4	Pea Ridge	Magnetite and hematite	55–58				Large	Engineering and Mining Journal (1957, p. 72).
5	Southeastern Missouri	Limonite	41–50	0.09	1.3			Ballinger and Pesonen (1948, p. 7); Bishop (1952, p. 17); Crane (1912, p. 70).
	Do	do	Less than 40.				3	Bishop (1952, p. 17).

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TABLE 4.—*Iron-ore resources of areas or deposits in the United States, by regions and States*—Continued

Locality No. (pl. 2)	Area or deposit (alternate name in parentheses)	Types of ore (in order of abundance)	Approximate iron content (percent)	Estimated resources of crude ore (millions of long tons): Reserves and potential ore: Measured	Indicated	Inferred	Potential ore, unclassified	Reference
				CENTRAL AND GULF REGION—Continued				
				Oklahoma				
1	Arbuckle Mountain district, north-central part.	Limonite	[34] 50				[34] [35] 1	
2	Arbuckle Mountain district, western part.	do	[34] 50				[34] [36] 0.37	
3	Lake Lawtonka area	Titaniferous magnetite	[33] 62				[37] 0.35	Chase (1952, p. 42–43).
4	Wichita Mountains, Iron Mountain-Mountain Glenn-Mount Baker area.	do	45–54				[34] [38] 1	Chase (1950b, p. 10).
				South Dakota				
1	Iron Mountain	Hematite and limonite	48					Connolly and O'Harra (1929, p. 215–216).
				Texas				
1	North basin [39]	Limonite	[9] 40	*26	*58		22	Perkins and Lonsdale (1955, p. 45).
	Do	Siderite	[9] 40	13	15		24	Do.
2	South basin [39]	Limonite	[9] 40	*30	*17		11	Do.
	Do	Siderite	[9] 40	1.6	0.14		0.56	Do.

WESTERN REGION

Arizona

1	Apache (Canyon Creek-Swamp Creek Mountain).	Hematite	46			14		Julihn and Moon (1945, p. 10).
2	Iron Mine (Seligman)	do	60				Small	
3	New Planet	do	60		1.2			Do.
4	Pikes Peak	Hematite and magnetite	30			100		Farnham and Havens (1957, p. 23).

California

1	Cave Canyon	Magnetite and hematite	60–67	[40] 0.37	1.1	1.8		Lamey (1945d, p. 79, 83).
2	Eagle Mountains	do	50	*28		*15		Hadley (1945, p. 12–13).
3	Hirz Mountain (Jennings)	do				[41] 0.26		Lamey (1945h, p. 136).
4	Iron Hat (Ironclad)	do	50		0.08	0.2		Lamey (1945f, p. 108).
5	Iron Mountain - Bessemer (Lava Bed).	Magnetite	30–65		5.3			Lamey (1945a, p. 37–38).
6	Iron Mountain-Iron King (Silver Lake).	do	54–60		5.2	1	0.37	Lamey (1945b, p. 55, 57).
7	Kingston	Magnetite and hematite	60					Hewett (1948, p. 205).
	Do	do					Moderate	
8	Minarets	Magnetite	60	2.5		2.5	[42] 2	Trask and Simons (1945, p. 123, 127).
9	Old Dad Mountain	Magnetite and hematite	52–57		0.45			Lamey (1945c, p. 66–67).
10	San Gabriel Mountains	Titaniferous magnetite					Large	Oakeshott (1948, p. 264).
11	Shasta-California	Magnetite	50		[43] 1.8			Lamey (1945i, p. 153).
12	Vulcan	Magnetite and hematite	50	2.5	[44] 2.5	[44] 2.4		Lamey (1945e, p. 91, 94); Severy (1948, p. 2, 7); Wright and others (1953, p. 100).

Colorado

1	Cebolla	Titaniferous magnetite and limonite.	55					Singewald (1912, p. 570).
2	Orient-Bennett	Limonite	[45] 43				5	Leith and Liddell (1936, p. 107); Stone (1934, p. 322).
3	Red Cliff-Battle Mountain	Manganiferous siderite and limonite.	38				0.75	Umpleby (1917, p. 1140–1141).
4	Taylor Peak	Magnetite	64				3.5	Harder (1909b, p. 194).

Idaho

1	Iron Mountain	Magnetite and specular hematite.	62	0.02	0.13–0.18			Mackin (1953a, p. 138).
2	Little Sawmill Creek	Specular hematite	[46] 54				Small	
3	Poison and McKim Creeks	do						

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				Reserves and potential ore			Potential ore, unclassified	
				Measured	Indicated	Inferred		
				WESTERN REGION—Continued				
				Montana				
1	Blackfeet Indian Reservation	Titaniferous magnetite	27-49					Stebinger (1914, p. 335).
	Do	do					Moderate	
2	Carter Creek (Dillon) [47]	Magnetite	30				Large	
3	Choteau	Titaniferous magnetite	39	4			Large	
4	Iron Cross (Radersburg) [48]	do	45				Moderate	
5	Iron Mountain (Neihart)	Hematite	57				Small	
6	Running Wolf (Stanford)	Magnetite and hematite	59		0.6			Julihn and Moon (1945, p. 11).
	Do	do				1.3		DeMunck (1956, p. 15).
7	Sheep Creek (White Sulphur Springs).	Hematite and limonite	44			5		DeMunck (1956, p. 40); Goodspeed (1946, p. 10).
	Do	do	32				Large	Julihn and Moon (1945, p. 11); Roby (1950, p. 34).
8	Southern Cross	Magnetite	40			2		Julihn and Moon (1945, p. 11).
				Nevada				
1	Barth	Hematite	50				Small	
2	Buena Vista Hills, Buena Vista and Segerstrom-Heizer mines.	Magnetite	60				Moderate	Reeves and Kral (1955, p. 21).
3	Coppereid	Hematite	60				Small	
4	Dayton	Magnetite and hematite	47	2	2.2	1.3		Butler (1945, p. 9).
5	DeLong mine, Jackson Range	Magnetite	60				Small	
6	Minnesota	do	55				Small	
7	Modarelli (Requa)	Hematite	55					Kral (1947c, p. 2).
	Do	do					Large	
8	Phelps Stokes	Magnetite	47-63					Kral (1947d, p. 4-5).
	Do	do					Small	

New Mexico

1	Boston Hill	Manganiferous hematite and magnetite.	35–40		5	5		Kelley (1949, p. 51).
2	Caballos Range	Hematite	25–35			63		Do.
3	Capitan	Magnetite and hematite	45–55	1		2.1		Do.
4	Chloride Flat	Manganiferous hematite and limonite.	35–40		0.1	0.5		Do.
5	Fierro-Hanover	Magnetite and hematite	35–55	17		33		Kelley (1949, p. 50).
6	Iron Mountain	do	35–40		1	3.5		Kelley (1949, p. 51).
			20–35		1.5	4.5		Do.
7	Jones	Magnetite	40–60		0.14	0.4		Do.
8	Orogrande	Magnetite and hematite	40–55		0.22	0.15		Do.
9	Sycamore-Bear Canyon	Hematite	25			5		Do.

Oregon

1	Coos Bay	Titaniferous magnetite					Small	
2	Satterfield Homestead (Tolman).	Magnetite and hematite	52				0.76	Hodge (1935, p. 31–32).
3	Scappoose	Limonite	39		4			Hotz (1953a, p. 86, 92).

Utah

1	Bull Valley	Hematite and magnetite	52			0.95		Julihn and Moon (1945, p. 13).
2	Iron Springs	do	45–50	*100		*250	150	Allsman (1948, p. 2).

Washington

1	Blewett	Magnetite and hematite	46	[49] 0.01	[49] 0.05	[49] 0.14		Broughton (1944, p. 14, 41).
2	Buckhorn	Magnetite	47					Broughton (1943b, p. 14).
3	Cle Elum	Magnetite and hematite	41	[50] 2.9	[50] 0.58	[50] 2.1		Lamey and Hotz (1952, p. 60).
4	Deep Lake (Bechtol and Thompson properties).	Limonite	60	0.05	0.27	0.58		Glover (1942, p. 20); Shedd, Jenkins, and Cooper (1922, pl. 1).
5	Deer Trail (Read)	Magnetite	60	0.005	0.1	0.5		Glover (1942, p. 19); Shedd, Jenkins, and Cooper (1922, pl. 1).
6	Hamilton (Iron Mountain)	Manganiferous hematite and magnetite.	38	0.02	0.1	0.5		Glover (1942, p. 16); Shedd, Jenkins, and Cooper (1922, pl. 1).
7	Sumas Mountain	Hematite	48					
8	Summit (Denny and Guye properties).	Magnetite	55–69	0.015		0.3		Glover (1942, p. 8); Shedd, Jenkins, and Cooper (1922, pl. 1).

See footnotes at end of table, p. 100–101.

TABLE 4.—*Iron-ore resources of areas or deposits in the United States, by regions and States*—Continued

Locality No. (pl. 2)	Area or deposit (alternate name in parentheses)	Types of ore (in order of abundance)	Approximate iron content (percent)	Estimated resources of crude ore (millions of long tons)				Reference
				Reserves and potential ore			Potential ore, unclassified	
				Measured	Indicated	Inferred		
				WESTERN REGION—Continued				
				Wyoming				
1	Atlantic City	Magnetite	35				Large	Mining Record (1957, p. 7).
2	Hartville (Sunrise)	Hematite	55	*20–30				Mikami (1944, p. 6).
3	Iron Mountain [51] (Laramie Range).	Titaniferous magnetite	42–50		3	0.6		Newhouse and Hagner (1951, p. 17).
	Do	do	30–42		1.6	1.3		Do.
	Do	do	18–30		0.9	1.7		Do.
4	Shanton (Laramie Range)	do	50					Hild (1953, p. 6–7).
	Do	do				Small		

[1] In manganiferous shale with high silica and high phosphorus content.
[2] Massive ore. Average grade of disseminated ore, 30 percent. Major part of ore being mined will perhaps not exceed 46 percent Fe.
[3] Should be available under normal economic conditions.
[4] At a depth possibly favorable for mining now; its recovery will depend upon economic conditions.
[5] Includes ore in the producing mines that is at too great a depth to be mined economically and ore that is left in about 80 abandoned mines.
[6] Probable range for large-scale opencut mining, which is the more likely basis of operation in the foreseeable future. Small high-grade ore shoots (55 percent Fe) are present, but cannot be worked except under emergency conditions.
[7] Ore in place.
[8] Possibly a large part of the higher grade ore would have an iron content of between 50 and 55 percent.
[9] Washed ore.
[10] Manganese oxide minerals are also present.
[11] Estimated ore to depth of 100 feet.
[12] Reserves computed from drill-hole data. Tonnages are tentative as study is incomplete. Geologic evidence indicates that ore extends beyond the limits of the area described in the report cited, and therefore the estimates of inferred reserves are conservative. Minimum thickness of commercially minable ore bodies is estimated as 3–4 feet.
[13] Based on an underground-mining recovery of 75 percent for undeveloped areas and 50 percent for developed areas, some of which have not been mined out.
[14] Only part of this can be considered present reserves. Minimum thickness of commercially minable ore bodies is estimated as 2–4 feet.
[15] In downward extension of the currently producing bed. Additional potential ore might be added to this estimate if more remote sources within the district were considered.
[16] Written communication from H. D. Pallister, geologist, Geological Survey of Alabama, University, Ala.
[17] Ore in the area within Alabama that extends beneath Lookout Mountain plateau from bordering outcrops, assuming an average thickness of 3 feet, an area of 350 square miles, and a volume of 12 cubic feet per ton.
[18] Based on extension of the ore beds from bordering outcrops to great depth beneath Lookout Mountain plateau within Georgia, assuming an average thickness of 3 feet for the ore beds.
[19] Alteration product (limonite).
[20] Some manganiferous ore.
[21] Written communication from J. T. Singewald, Jr., director, Maryland Department of Geology, Mines and Water Resources, Baltimore, Md.
[22] Washed ore, in part.
[23] Written communication from H. D. Pallister, Geological Survey of Alabama, giving estimate by him and E. F. Burchard, U.S. Geological Survey, based on extension of the ore beds from bordering outcrops to great depth beneath Lookout Mountain plateau within Tennessee, assuming an average thickness of 3 feet for the ore beds.
[24] Scattered deposits.
[25] Recalculated from the estimate by Roberts and Crago (1948, p. 2).
[26] Estimate of iron-formation to depth of about 500 feet below bedrock surface.
[27] Mostly manganiferous; much ore contains 2–10 percent Mn.
[28] From open-pit mines; the only taconite now being used.

[29] From underground mines.

[30] Estimated ore to depth of 350 feet. Lean cherty iron-formation and partly altered iron-formation, which contain an average of 36 percent Fe, predominate in the district.

[31] Estimated ore to depth of 1,250 feet. Ore has too high a sulfur and phosphorus content to be of current economic value.

[32] Written communication from E. L. Clark, State geologist, Missouri Division Geol. Survey and Water Resources, Rolla, Mo.

[33] Concentrates.

[34] Written communication from W. E. Ham, geologist, Oklahoma Geological Survey, Norman, Okla.

[35] Scattered deposits in dolomite, each containing 3,000–75,000 long tons of recoverable ore.

[36] Scattered deposits in dolomite, each containing 3,000–50,000 long tons of recoverable ore.

[37] Ore is ilmenite-magnetite containing 9.8 percent TiO_2, associated with ilmenite in alluvial sands. Deposit drilled.

[38] Massive magnetite containing 14–18 percent TiO_2. Occurs chiefly as dikes in olivine-rich rocks. Deposits not drilled.

[39] Revision of estimates that were made by E. B. Eckel (1938), based on current data; the increase is due primarily to larger reserves of carbonate ore, especially in the North basin. The figures are still considered preliminary; final estimates can be obtained only after detailed geologic mapping followed by extensive test-pit study.

[40] Written communication from T. E. Gay, Jr., assistant mining geologist, California Division of Mines, Department of Natural Resources, San Francisco, Calif.

[41] Per 100 feet of depth.

[42] Low iron content.

[43] With an iron cutoff of 25 percent and an average iron content of 41 percent, 3.9 million long tons are estimated.

[44] Calculated from references cited.

[45] Average of ore shipped in 1930.

[46] Average ore from shaft and trench.

[47] Written communication from Montana Bureau of Mines and Geology, based on U.S. Bureau of Mines drill logs and analyses.

[48] Written communication from Montana Bureau of Mines and Geology.

[49] Fine-grained ore only; conglomeratic beds not included.

[50] Fine-grained ore.

[51] Estimates by the Union Pacific Railroad based on magnetometer surveys in 1951–53 and drilling in 1952–53 indicate much larger resources. (See Pinnel and Marsh, 1954, p. 8–10.)

NOTE: Resources of greatest national importance are indicated by asterisk (*).

TABLE 5.—*Iron-ore resources of Alaska and Puerto Rico*

<table>
<tr><th rowspan="3">Locality No. (pl. 2)</th><th rowspan="3">Area or deposit</th><th rowspan="3">Type of ore</th><th rowspan="3">Approximate iron content (percent)</th><th colspan="4">Estimated resources of crude ore (millions of long tons)</th><th rowspan="3">Reference</th></tr>
<tr><th colspan="3">Reserves and potential ore</th><th rowspan="2">Potential ore, unclassified</th></tr>
<tr><th>Measured</th><th>Indicated</th><th>Inferred</th></tr>
<tr><td colspan="9">ALASKA</td></tr>
<tr><td>1</td><td>Haines-Klukwan</td><td>Titaniferous magnetite</td><td>20</td><td></td><td></td><td></td><td>Large</td><td>Killeen (1952, p. 417–418, 421).</td></tr>
<tr><td>2</td><td>Jumbo Basin, Prince of Wales Island.</td><td>Magnetite</td><td>[1] 45</td><td></td><td colspan="2">0.37</td><td></td><td>Kennedy (1953, p. 39).</td></tr>
<tr><td>3</td><td>Kasaan Peninsula, Prince of Wales Island:</td><td></td><td></td><td></td><td></td><td></td><td></td><td></td></tr>
<tr><td></td><td>Mount Andrew-Mamie</td><td>do</td><td>[1] 50</td><td></td><td>2.3</td><td>0.91</td><td></td><td>Warner (1945, p. 2).</td></tr>
<tr><td></td><td>Poor Man</td><td>do</td><td>[1] 52</td><td colspan="2">0.9</td><td>0.45</td><td></td><td>Warner and Walton (1944, p. 6).</td></tr>
<tr><td></td><td>Tolstoi Mountain</td><td>do</td><td>[1] 30–50</td><td></td><td></td><td></td><td>Small</td><td>Warner and Stefansson (1945, p. 2).</td></tr>
<tr><td>4</td><td>Snettisham</td><td>Titaniferous magnetite</td><td>12</td><td></td><td></td><td></td><td>Large</td><td>Thorne and Wells (1956, p. 1).</td></tr>
<tr><td colspan="9">PUERTO RICO</td></tr>
<tr><td>1</td><td>Juncos</td><td>Magnetite</td><td>60</td><td></td><td>Small</td><td></td><td></td><td>Dutton (1955, p. 206).</td></tr>
<tr><td>2</td><td>Mayagüez Mesa</td><td>Lateritic limonite</td><td>40</td><td></td><td></td><td></td><td>Large</td><td>Carr (1952, p. 425).</td></tr>
</table>

[1] Total iron, rather than magnetic iron.

TABLE 6.—*Alphabetical list of iron deposits in the United States, including Alaska and Puerto Rico.*

[Symbols for regions: CG, central and gulf; LS, Lake Superior; NE, northeastern; SE, southeastern; and W, western]

Area or deposit (alternate name in parentheses)	Region	State or Territory	Number on pl. 2 and in tables 4 and 5
Alabama, eastern	SE	Alabama	2
Alabama, southern	SE	do	9
Allegany and Garrett Counties	SE	Maryland	1
Alleghany County and vicinity	SE	Virginia	1
Apache (Canyon Creek-Swamp Creek Mountain).	W	Arizona	1
Appalachian region, Kentucky. See Kentucky Appalachian region, northeastern.			
Arbuckle Mountain district, north-central and western parts.	CG	Oklahoma	1, 2
Arkansas, northeastern	CG	Arkansas	2
Arnold Hill, Ausable Forks area	NE	New York	1
Aroostook County, central, northern, and southern districts.	NE	Maine	1, 2, 3
Atlantic City	W	Wyoming	1
Ausable Forks area, New York. See Arnold Hill.			
Ballou belt	SE	North Carolina	1
Baraboo range	LS	Wisconsin	1
Barnardsville, Tennessee. See Chamberlain-Barnardsville.			
Barth	W	Nevada	1
Battle Mountain, Colorado. See Red Cliff-Battle Mountain.			
Bear Canyon, New Mexico. See Sycamore-Bear Canyon.			
Bechtol, Washington. See Deep Lake.			
Bennett, Colorado. See Orient-Bennett.			
Benson mines	NE	New York	2
Bessemer, California. See Iron Mountain-Bessemer.			
Big ore bank	SE	North Carolina	2
Birmingham	SE	Alabama	1
Blackfeet Indian Reservation	W	Montana	1
Black River Falls	LS	Wisconsin	2
Blewett	W	Washington	1
Blue Ridge	SE	Virginia	2
Boston Hill	W	New Mexico	1
Bourbon-Sullivan	CG	Missouri	1
Boyertown	NE	Pennsylvania	1
Brewster belt, New York. See Croton mine.			
Broncho	SE	Georgia	1
Buckhorn	W	Washington	2
Bucksville, Alabama. See Woodstock-Bucksville.			
Buena Vista Hills (Buena Vista and Segerstrom-Heizer).	W	Nevada	2
Bull Valley	W	Utah	1
Caballos Range	W	New Mexico	2

TABLE 6.—*Alphabetical list of iron deposits in the United States, including Alaska and Puerto Rico*—Continued

[Symbols for regions: CG, central and gulf; LS, Lake Superior; NE, northeastern; SE, southeastern; and W, western]

Area or deposit (alternate name in parentheses)	Region	State or Territory	Number on pl. 2 and in tables 4 and 5
California, California. See Shasta-California.			
Camp Butner, North Carolina. See Knap of Reeds.			
Canyon Creek, Arizona. See Apache.			
Capitan	W	New Mexico	3
Cardiff, Tennessee. See Rockwood-Cardiff.			
Carroll-Grayson district	SE	Virginia	3
Carter Creek (Dillon)	W	Montana	2
Cartersville	SE	Georgia	2
Catoctin Mountain	SE	Maryland	2, 3
Cave Canyon	W	California	1
Cebolla	W	Colorado	1
Cenchatt	SE	Georgia	3
Chamberlain-Barnardsville	SE	Tennessee	1
Chattanooga, Tennessee. See North Chattanooga.			
Chestnut Hill ore banks	SE	Maryland	4
Chloride Flat	W	New Mexico	4
Choctaw County, Miss. See Webster County.			
Choteau	W	Montana	3
Cle Elum	W	Washington	3
Clove, New York. See Fishkill-Clove.			
Coastal plain	SE	Maryland	5
Collyarton, Georgia. See Dirtseller Mountain.			
Colvin Mountain, Alabama. See Greens Creek-Colvin Mountain.			
Coos Bay	W	Oregon	1
Copeland	SE	Georgia	4
Coppereid	W	Nevada	3
Cornwall	NE	Pennsylvania	4
Cranberry	SE	North Carolina	3
Crittenden County, Ky. See Trigg County.			
Croton mine, Brewster belt	NE	New York	3
Crown Point, New York. See Hammondville-Crown Point.			
Cumberland Plateau	SE	Tennessee	2
Cuyuna range	LS	Minnesota	1
Dayton	W	Nevada	4
Deep Lake (Bechtol and Thompson)	W	Washington	4
Deer Trail (Read)	W	do	5
DeLong mine, Jackson Range	W	Nevada	5
Denny, Washington. See Summit.			
Dickinson County, Mich. See Menominee range, Michigan.			
Dillon, Montana. See Carter Creek.			
Dillsburg	NE	Pennsylvania	5
Dirtseller Mountain	SE	Georgia	5
Dover district	NE	New Jersey	1

TABLE 6.—*Alphabetical list of iron deposits in the United States, including Alaska and Puerto Rico*—Continued

[Symbols for regions: CG, central and gulf; LS, Lake Superior; NE, northeastern; SE, southeastern; and W, western]

Area or deposit (alternate name in parentheses)	Region	State or Territory	Number on pl. 2 and in tables 4 and 5
Eagle Cliff	SE	Georgia	6
Eagle Mountains	W	California	2
Estelle	SE	Georgia	7
Euchee	SE	Tennessee	4
Evitts and Tussey Mountains	SE	Maryland	6
Fierro-Hanover	W	New Mexico	5
Fillmore County	LS	Minnesota	2
Fishkill-Clove	NE	New York	4
Florence area, Wisconsin. See Menominee range, Wisconsin.			
Forest of Dean group	NE	New York	5
Garrett County, Maryland. See Allegany and Garrett Counties.			
Georgia, northwestern	SE	Georgia	10
Glen Alice	SE	Tennessee	5
Gogebic range, Michigan	LS	Michigan	1
Gogebic range, Wisconsin	LS	Wisconsin	3
Gossan Lead	SE	Virginia	4
Grace mine	NE	Pennsylvania	6
Grayson district, Virginia. See Carroll-Grayson district.			
Greasy Cove	SE	Alabama	3
Greenbrier and Pocahontas Counties	SE	West Virginia	2
Greens Creek-Colvin Mountain	SE	Alabama	4
Guye, Washington. See Summit.			
Haines-Klukwan		Alaska	1
Hamilton (Iron Mountain)	W	Washington	6
Hammondville-Crown Point	NE	New York	6
Hanging Rock	SE	Kentucky	1a
Hanover, New Mexico. See Fierro-Hanover.			
Harlem Valley	NE	New York	7
Hartville (Sunrise)	W	Wyoming	2
Heizer, Nevada. See Buena Vista Hills.			
Hirz Mountain (Jennings)	W	California	3
Inman	SE	Tennessee	6
Iron County, Michigan. See Menominee range, Michigan.			
Iron Cross (Radersburg)	W	Montana	4
Iron Hat (Ironclad)	W	California	4
Iron King, California. See Iron Mountain-Iron King.			
Iron Mine (Seligman)	W	Arizona	2
Iron Mine Hill	NE	Rhode Island	1
Iron Mountain	W	Idaho	1
Iron Mountain	CG	Missouri	3
Iron Mountain (Neihart)	W	Montana	5
Iron Mountain	W	New Mexico	6
Iron Mountain, Oklahoma. See Wichita Mountains.			
Iron Mountain	CG	South Dakota	1

TABLE 6.—*Alphabetical list of iron deposits in the United States, including Alaska and Puerto Rico*—Continued

[Symbols for regions: CG, central and gulf; LS, Lake Superior; NE, northeastern; SE, southeastern; and W, western]

Area or deposit (alternate name in parentheses)	Region	State or Territory	Number on pl. 2 and in tables 4 and 5
Iron Mountain, Washington. See Hamilton.			
Iron Mountain (Laramie Range)	W	Wyoming	3
Iron Mountain-Bessemer (Lava Bed)	W	California	5
Iron Mountain-Iron King (Silver Lake)	W	do	6
Iron Ridge district, Wisconsin. See Mayville-Iron Ridge district.			
Iron Springs	W	Utah	2
Ironclad, California. See Iron Hat.			
Jackson Range, Nevada. See DeLong mine.			
Jennings, California. See Hirz Mountain.			
Jones	W	New Mexico	7
Jumbo Basin, Prince of Wales Island		Alaska	2
Juncos		Puerto Rico	1
Kasaan Peninsula, Prince of Wales Island		Alaska	3
Kentucky Appalachian region, northeastern.	SE	Kentucky	1a, b
Kingston	W	California	7
Klukwan, Alaska. See Haines-Klukwan.			
Knap of Reeds (Camp Butner)	SE	North Carolina	4
Lafayette County	SE	Mississippi	1
LaFollette area, Tennessee. See Tennessee, northeastern.			
Lake Lawtonka area	CG	Oklahoma	3
Lake Sanford	NE	New York	8
Laramie Range, Wyoming. See Iron Mountain and Shanton.			
Lava Bed, California. See Iron Mountain-Bessemer.			
Lawtonka area, Oklahoma. See Lake Lawtonka area.			
Lee-Wise district	SE	Virginia	5
Little Sawmill Creek	W	Idaho	2
Livingston County, Kentucky. See Trigg County.			
Lookout Mountain area	SE	Georgia	8
Lookout Mountain plateau	SE	Alabama	5
Lyon County, Kentucky. See Trigg County.			
Lyon Mountain belt	NE	New York	9
Magnet Cove	CG	Arkansas	1
Mamie, Alaska. See Kasaan Peninsula.			
Marquette range	LS	Michigan	2
Marshall County, southeastern part	SE	Mississippi	2
Mayagüez Mesa		Puerto Rico	2
Mayville-Iron Ridge district	LS	Wisconsin	5
McKim Creek, Idaho. See Poison and McKim Creeks.			
Menominee range, Michigan	LS	Michigan	3

TABLE 6.—*Alphabetical list of iron deposits in the United States, including Alaska and Puerto Rico*—Continued

[Symbols for regions: CG, central and gulf; LS, Lake Superior; NE, northeastern; SE, southeastern; and W, western]

Area or deposit (alternate name in parentheses)	Region	State or Territory	Number on pl. 2 and in tables 4 and 5
Menominee range, Florence area, Wisconsin.	LS	Wisconsin	4
Mesabi range	LS	Minnesota	3
Minarets	W	California	8
Mineville-Port Henry	NE	New York	10
Minnesota	W	Nevada	6
Missouri, central	CG	Missouri	2
Missouri, southeastern	CG	Missouri	5
Modarelli (Requa)	W	Nevada	7
Montgomery County, Miss. See Webster County.			
Mountain Glenn, Oklahoma. See Wichita Mountains.			
Mount Andrew-Mamie, Alaska. See Kasaan Peninsula.			
Mount Baker area, Oklahoma. See Wichita Mountains.			
Murphree's Valley	SE	Alabama	6
Neihart, Montana. See Iron Mountain.			
New England-Wildwood	SE	Georgia	9
New Planet	W	Arizona	3
New York, west-central	NE	New York	15
North Basin	CG	Texas	1
North Chattanooga	SE	Tennessee	7
Ogden mines	NE	New Jersey	2
Ohio, southeastern	NE	Ohio	1
Old Dad Mountain	W	California	9
Ooltewah	SE	Tennessee	9
Orient-Bennett	W	Colorado	2
Orogrande	W	New Mexico	8
Oxford mines	NE	New Jersey	3
Pea Ridge	CG	Missouri	4
Pennsylvania, central, hematite area	NE	Pennsylvania	3
Pennsylvania, central, limonite area other than Scotia.	NE	do	2
Pennsylvania, western	NE	do	10
Phelps Stokes	W	Nevada	8
Pikes Peak	W	Arizona	4
Planet, Arizona. See New Planet.			
Pocahontas County, W. Va. See Greenbrier and Pocahontas Counties.			
Poison and McKim Creeks	W	Idaho	3
Poor Man, Alaska. See Kasaan Peninsula.			
Port Henry, New York. See Mineville-Port Henry.			
Prince of Wales Island, Alaska. See Jumbo Basin and Kasaan Peninsula.			
Pudding Ridge	SE	Georgia	11
Pulaski-Smyth district	SE	Virginia	6
Radersburg, Montana. See Iron Cross.			
Read, Washington. See Deer Trail.			

TABLE 6.—*Alphabetical list of iron deposits in the United States, including Alaska and Puerto Rico*—Continued

[Symbols for regions: CG, central and gulf; LS, Lake Superior; NE, northeastern; SE, southeastern; and W, western]

Area or deposit (alternate name in parentheses)	Region	State or Territory	Number on pl. 2 and in tables 4 and 5
Red Cliff-Battle Mountain	W	Colorado	3
Requa, Nevada. See Modarelli.			
Ringwood district	NE	New Jersey	4
Rising Fawn	SE	Georgia	12
Rittenhouse Gap	NE	Pennsylvania	7
Rockwood-Cardiff	SE	Tennessee	10
Rose Run area	SE	Kentucky	2
Running Wolf (Stanford)	W	Montana	6
Russellville	SE	Alabama	7
St. Lawrence County, southeastern, except Benson mines.	NE	New York	12
Sanford, New York. See Lake Sanford.			
San Gabriel Mountains	W	California	10
Saranac Valley	NE	New York	11
Satterfield Homestead (Tolman)	W	Oregon	2
Scappoose	W	do	3
Scotia	NE	Pennsylvania	8
Segerstrom-Heizer, Nevada. See Buena Vista Hills.			
Seligman, Ariz. See Iron Mine.			
Shanton (Laramie Range)	W	Wyoming	4
Shasta-California	W	California	11
Sheep Creek (White Sulphur Springs)	W	Montana	7
Shinbone Ridge	SE	Alabama	8
Silver Lake, California. See Iron Mountain-Iron King.			
Slate Creek area	SE	Kentucky	1b
Smyth district, Virginia. See Pulaski-Smyth district.			
Snettisham		Alaska	4
South Basin	CG	Texas	2
Southeast Missouri	CG	Missouri	5
South Fork Mountain	SE	West Virginia	3
Southern Cross	W	Montana	8
Springfield mine	SE	Maryland	7
Springville-Whitney	SE	Alabama	10
Stanford, Montana. See Running Wolf.			
Sterling belt	NE	New York	13
Sterling Lake	NE	do	14
Sterling-Ringwood, New York-New Jersey. See Sterling Lake and Ringwood district.			
Stokes, Nevada. See Phelps Stokes.			
Sullivan, Missouri. See Bourbon-Sullivan.			
Sumas Mountain	W	Washington	7
Summit (Denny and Guye)	W	do	8
Sunrise, Wyoming. See Hartville.			
Swamp Creek Mountain, Arizona. See Apache.			
Sycamore-Bear Canyon	W	New Mexico	9
Talladega	SE	Alabama	11
Taylor Peak	W	Colorado	4
Taylor Ridge	SE	Georgia	13

TABLE 6.—*Alphabetical list of iron deposits in the United States, including Alaska and Puerto Rico*—Continued

[Symbols for regions: CG, central and gulf; LS, Lake Superior; NE, northeastern; SE, southeastern; and W, western]

Area or deposit (alternate name in parentheses)	Region	State or Territory	Number on pl. 2 and in tables 4 and 5
Tennessee, eastern	SE	Tennessee	3
Tennessee, northeastern, including La-Follette area.	SE	do	8
Thompson, Washington. See Deep Lake.			
Tolley ore bank	SE	Maryland	8
Tolman, Oregon. See Satterfield Homestead.			
Tolstoi Mountain, Alaska. See Kasaan Peninsula.			
Trigg, Lyon, Livingston, and Crittenden Counties.	SE	Kentucky	3
Tuscarawas County and adjacent areas	NE	Ohio	2
Tussey Mountain, Maryland. See Evitts and Tussey Mountains.			
Valley River belt	SE	North Carolina	5
Vera Cruz	NE	Pennsylvania	9
Vermilion range	LS	Minnesota	4
Vulcan	W	California	12
Waukon	CG	Iowa	1
Webster County and borders of Montgomery and Choctaw Counties.	SE	Mississippi	3
West Virginia, central	SE	West Virginia	1
Western Highland Rim	SE	Tennessee	11
White Rocks	NE	Pennsylvania	11
White Sulphur Springs, Montana. See Sheep Creek.			
Whitney, Alabama. See Springville-Whitney.			
Wichita Mountains (Iron Mountain-Mountain Glenn-Mount Baker area).	CG	Oklahoma	4
Wildwood, Georgia. See New England-Wildwood.			
Wills Mountain	SE	Maryland	9
Wills Valley, northwest and southeast sides.	SE	Alabama	12, 13
Wise district, Virginia. See Lee-Wise district.			
Woodstock	SE	Alabama	14
Woodstock-Bucksville	SE	do	15

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