NB: most important piece for discussion of coal

Some Geographic Influences of the Lake Superior Iron Ores

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SOME GEOGRAPHIC INFLUENCES OF THE LAKE SUPERIOR IRON ORES

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No single resource, unless it be coal or soil, is so vital to the economic growth of the modern nation as iron. Iron ore deposits situated like those of the Lake Superior district, of such high grade, in such a limited area, and so easily mined on a large scale, could not fail to affect the whole nation. Their production, utilization, and conservation concern the whole people. This paper treats only a few of these effects. A complete discussion would involve much of the industrial and commercial development of the country, and much of its political history, during the last half century.

The Ore Fields

Location. The Lake Superior ore district consists of five principal ranges: the Marquette and Menominee in Michigan, the Penokee-Gogebic in Michigan and Wisconsin, and the Mesabi and Vermilion in northeastern Minnesota. The latter are 60 to 90 miles northwest of Duluth-Superior and Two Harbors, from which the ore is shipped to lower Lake ports. The Marquette Range is near the city of Marquette, the Menominee Range near Escanaba, and the Penokee-Gogebic Range 25 to 50 miles from Ashland. Thus each range has an adequate outlet by water, a factor of great significance in its development.

The Marquette Range. Iron ore was discovered in Michigan as early as 1830 and on the Marquette Range in 1844. The first mine was located early in 1845, and the first ore was taken from the region that year.[1] Three years later the first iron made in the Lake Superior country was produced from the ores of this mine. The second mine was opened in 1850, and the ore was hauled 16 miles to a new forge at the mouth of the Carp River. All ore was moved on sleighs in winter, as wagon transportation was impossible over the soft ground in summer. The cost of producing blooms under these conditions, and of shipping them to mills in Ohio and Pennsylvania, brought disaster to the early enterprises. "By the time the blooms were laid down in Pittsburg they had actually cost $200 a ton, and the market rate for iron was then $80 a ton."[2] By 1853 the iron companies gave up making iron in the ore region and definitely took up the problem of transporting the ore. In the fall of that year the first shipment of consequence (152 tons) was made, the ore going to Sharon, Pennsylvania. Four vessels moved the ore from Marquette to Sault Ste. Marie, where it was

[1] R. D. Williams: Transportation of Iron Ore on the Great Lakes, *Iron Trade Rev.*, Vol. 48, 1911, p. 545.

[2] *ibid.*, p. 546.

portaged around the rapids.[3] The ore proved to be of very high grade, and a demand for more was created.

Progress, however, was slow for a time. The ore deposits were in an unbroken forest, 14 miles from the Lake shore, and without suitable means of transport; they had to be portaged around the Saint Marys Rapids and reloaded; the Lake vessels were few and small; the ore had to be introduced into the market and many of the iron workers were reluctant to experiment, as some had declared the ore useless.

The iron-mining companies did much to hasten the undertaking and the completion of the Sault Canal, which overcame the great barrier to Lake Superior commerce. The canal did not solve the problem at once, however. A greater demand for iron was needed, one that the eastern mines could not meet. This came with the Civil War, and after 1861 the output of the Marquette Range increased rapidly (Fig. 1). It had no competitor in the Lake region until 1877, when it was producing a million tons of ore per year. At no time since 1880 has its output fallen below 1,300,000 tons, and in 1910 it reached 4,392,000 tons.

The ores of this range occur in rocks of middle and upper Huronian age, the former containing the principal deposits. They vary from a soft, hydrated hematite to hard specular ores with some magnetite. The available ores of the district (estimated at 110 million long tons) and those not available at present (estimated at 15.9 billion long tons) far ex-

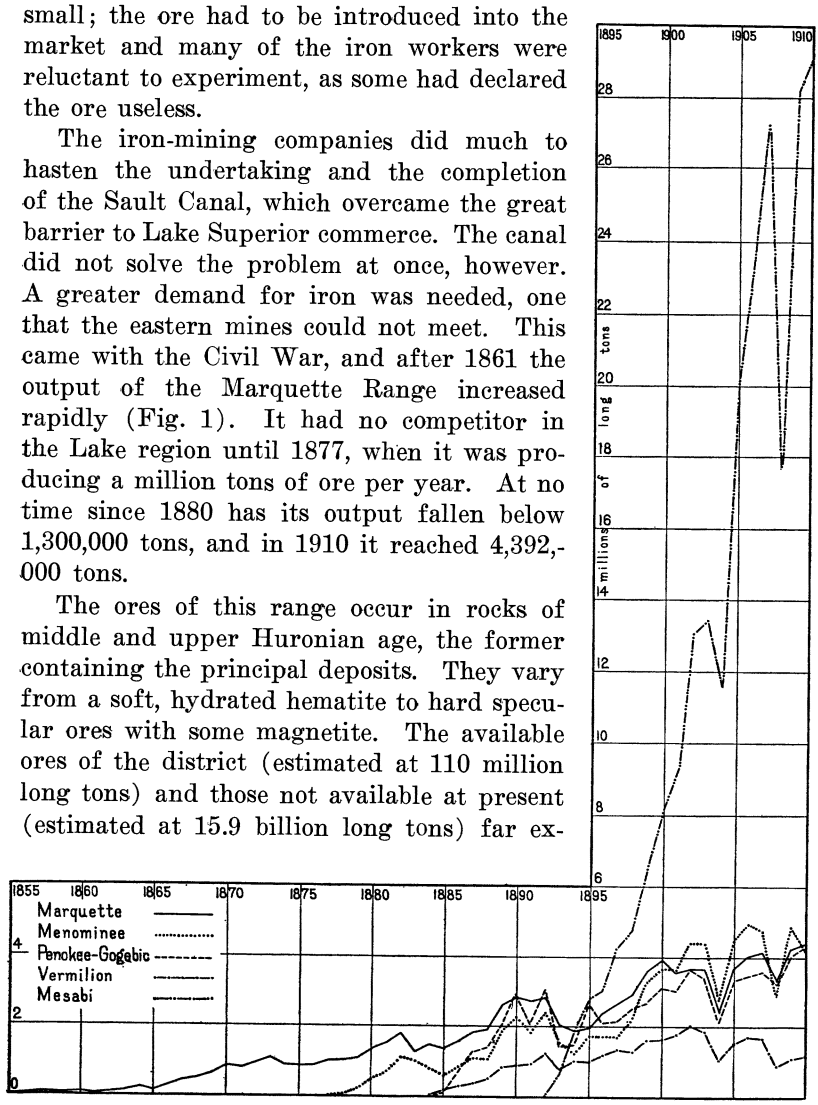

FIG. 1—Lake Superior district iron ore production, by ranges, 1855 to 1910.

[3] R. D. Williams: Transportation of Iron Ore on the Great Lakes, *Iron Trade Rev.*, Vol. 48, 1911, p. 545.

ceed those of any other range except the Mesabi. At the present rate of production its high-grade ores will be exhausted in the next twenty-five years. But before that time its lower grade ores (15 billion long tons) doubtless will have entered the market.

The Menominee Range. Iron ore deposits were known in the Menominee district at least as early as 1867.[4] Lack of transportation facilities and inadequate knowledge of the deposits delayed development until after the Chicago and Northwestern Railroad reached the region in 1871-72. The first shipment of importance was made in 1877, and more than one and a half million tons were mined in the first five years. The sixth year its production exceeded a million tons, an amount which it had taken the Marquette Range more than twenty years to equal. Except for slack years, which affected all ranges, its output has increased rapidly, passing the Marquette Range in 1904 and since falling below it only in 1908 and 1910.

The ore having commercial value at present occurs in the upper Huronian rocks and is confined to the southern part of the district. The ore-bearing rocks are folded complexly. The ores are chiefly gray, finely-banded hematites, with which are associated smaller amounts of flinty block hematite. The high-grade ores of this range are estimated at 80,000,000 tons, and the non-available ore at 7.3 billion tons.

The Penokee-Gogebic Range. The first ore, 1,022 tons, was shipped from the Penokee-Gogebic Range in 1884. The ores occur in upper Huronian rocks and are concentrated in large, irregular bodies. Some of the deposits reach a depth of more than a thousand feet. Most of the ore is a soft, hydrated hematite, but there is an abundance of hard, slaty ore. Only underground methods of mining are used. The high-grade ore of the district found a ready market, and the million-ton mark was exceeded the fourth year. In 1890 and 1892 it produced more than any other Lake Superior range. The Penokee-Gogebic Range has much high-grade ore (estimated at 95,000,000 long tons), while its non-available ores are small (some 3.9 billion long tons) compared with those of the other ranges.

The Vermilion Range. The ores of the Vermilion Range are of lower Huronian age, and are associated with intricately folded and highly metamorphosed rocks. They consist of dense, hard, blue or

[4] A. B. Swineford: History of the Lake Superior Iron District, Its Mines and Furnaces (1871), p. 129.

red hematite. Specular ores are seldom found, but brecciated ores are common. The presence of ore was known in 1850, but little or no effort was made to mine it until 1875. The mines were 70 miles from the Lake and all supplies and machinery had to be packed in; consequently little was shipped until a railroad was completed in 1884. This road reached Lake Superior at Two Harbors, which had been selected as the best place for docks, machine shops, saw mills, and round house. Not until 1892 did the output equal a million tons, and only once has it reached 2,000,000 tons. The failure of the district to attain large production is due not to an inferior quality of ore but to the policy of the owners. They can produce ore on other properties much more cheaply. Explorations in recent years show this range to contain large high-grade reserves.

The Mesabi Range. Iron ore in the Mesabi Range was reported at Gunflint Lake in 1852, but the first ore pit was not made until 1890. Other discoveries of rich ore followed rapidly, and in 1892 29,000 tons were produced. The next year the district produced nearly 2,000,000 tons, and by 1910 the output reached 29,200,000 tons.

These ores are of upper Huronian age, and in most places are covered thickly with drift. When this has been removed, great ore bodies of large horizontal extent, compared with their thickness, are exposed. This ore is a soft, porous, brown, red or blue hematite of high grade, and varies from a finely powdered to a compact mass. These conditions make open-pit mining with steam shovels very profitable, as the ore is loaded directly onto the railroad car in the mine. Conservative estimates give 3.1 billion tons of high-grade ore in the Mesabi Range, and more than 39 billion tons that are not available at present. It is therefore not only the greatest present producer, but, so far as known, has the greatest reserves of any Lake Superior range.

The Cayuna Range. For a number of years iron ore has been known to occur in the Cayuna Range, but its abundance elsewhere has delayed development. The first shipment was made in 1909, marking the advent of a new district. Drillings made in the last three years show the presence of high-grade ore, which may prove to be a very large addition to the Lake ore tonnage.

Ore Production: (a) Growth of Production. Except for occasional periods of depression, the production of each of the Lake Superior ranges has increased constantly. The production of the

Mesabi Range has been phenomenal (Fig. 1). Within four years its annual output exceeded that of any other range. In the nineteen years since its opening it has produced 45.5 per cent. of all the ore ever mined in the Lake region, and more than four-fifths (83.5%) as much as has been mined from all the other ranges. In 1910 its output made 67.2 per cent. of the total from the Lake Superior region, and was nearly seven times that of any other range. When it is remembered that three other ranges produce annually more than any other iron mining district in America, the importance of the Mesabi Range is given still greater emphasis. Its output in 1910 formed 54.8 per cent. of the entire ore production for the United States, and it still contains more than half (52.9%) of all the known iron ore of the country and 69.2 per cent. of all that is available under present conditions. The same year the Lake district supplied 81.5 per cent. of the ore mined in the United States. This region not only dominates the iron and steel situation in America, but produced in 1910 approximately 35 per cent. of the world's ore. Thus it makes the United States the world's greatest iron and steel producer. It will not soon lose its leadership, for it has 94.9 per cent. of all the known ore reserves of the United States and 78.3 per cent. of all the ore available under present mining and market conditions.

(*b*) *Reasons for Growth.* Several factors have caused this rapid development and relative importance of the region. (1) The ore is of high quality. Until recently most steel was made by the Bessemer process (Fig. 10), which demands high-grade, non-phosphorous ores. Much Lake Superior ore met these conditions and, once on the market, the demand for it grew rapidly. (2) Cheap mining methods are possible in most places. The character of the deposits made possible open-pit, steam-shovel mining on the Mesabi and comparatively cheap mining on some of the other ranges. In the open pits of the Mesabi district ore is mined at a cost of about 30 cents per ton, which is probably not equaled anywhere else in the world.[5] (3) Transportation methods by water and rail and mechanical devices for handling the cargoes have been so improved that the handicap of distance between the coke and ore has been nearly overcome. (4) The commercial and industrial development of the country has created an unprecedented market for iron and steel products. (5) The concentration of industries under the man-

[5] "At times the cost of digging ore . . . . may go as low as 6 or 7 cents per ton." Estimates by J. R. Finlay, *Eng. and Min. Journ.*, Vol. 87, 1909, p. 743.

agement of large corporations has made possible the expenditure of great sums in perfecting methods of mining, transportation, manufacture, and in the elimination of waste. While this has meant considerable profits to the corporations, it also has meant rapid development of the iron mines and of the iron and steel industries. No other industry gives employment to so many people and pays so much each year in wages.

Results of Development

Development of Transportation: (a) Railroads. When the first iron deposits were opened, 14 miles from Marquette, there was only an Indian trail leading to them. Some better method of transportation was imperative. In 1856 a plank road was completed from the mine to Lake Superior. It was soon converted into a tramway, using mules for power. The next year the tramway was replaced by the first railroad in the Lake Superior region. This road was designed as an outlet for the Marquette mines and was without competition until 1864. That year another railroad was completed from the mines to Escanaba, and it soon became an important ore carrier. With the opening of the Menominee Range this road secured additional ore traffic by extending branches into that district. When the Gogebic Range was opened in 1884 further stimulus was given to railroad building. The Milwaukee, Lake Shore, and Western extended its tracks to the region that year and to Ashland the year following. Since then each of these mining regions has been covered with a network of railroads. Numerous branches have been built to the many mines, both as outlets for the ore and to serve the return traffic created directly or indirectly by the development of the mining districts. Lumber, coal, and agricultural products have formed important freight items for all these roads, but iron ore gave the first stimulus to growth and continues to be the most important single item.

Before 1884 Minnesota had no railroads north of Duluth, except near the western border. That year the Duluth and Iron Range Railroad was completed from the Vermilion Range to Two Harbors. Progress in railroad building was slow, however, until 1890, when the first ore pit was opened on the Mesabi. News of this rich deposit spread rapidly, and there was a rush of explorers during the next two years. Two roads touched the range. The Duluth and Iron Range crossed at Mesabi on the way to Vermilion and the Duluth and Winnipeg (Great Northern) touched the range at Grand

Rapids, but both were far from the ore center. By 1892, however, the Duluth, Mesabi, and Northern was completed to the Mountain Iron Mine and later extended to Duluth, Biwabik, Virginia, Hibbing (1893), and Eveleth (1894). The Duluth and Iron Range also immediately extended branches to each of these mining points.[6] The financial depression of 1894-96 checked development, but since then the growth has been rapid, until now a closely woven railroad web serves the region. There are three railroads built especially for handling iron ore. They aggregate "over 700 miles, with an equipment of 282 engines, and over 16,700 cars."[7] They have so perfected the system of ore transportation that one road frequently handles more than a million tons a month.[8]

(*b*) *Great Lakes Commerce and Iron Ore:* (*1*) *The Sault Canal.* Before 1845 Lake Superior commerce was largely in furs. The ground scarcely had been broken for copper and iron mining. The rapids of the Saint Marys River prevented through water traffic with the lower Lakes. All ore, machinery, and other supplies had to be portaged around the rapids and reshipped. As the value of the mines became better known the necessity of a canal was realized. The extensive development of the region was impossible without it. In 1850 750,000 acres of land were given to the state by the Federal government for the purpose, and a 12-foot canal was completed in 1855. Its opening marked the birth of a new era. The canal admitted vessels of about 400 tons burden and fixed the size of the first ore carriers. The Civil War supplied a new market for the ore and hastened development in northern Michigan. Canal traffic increased rapidly, and the canal was soon wholly inadequate to meet the growing needs of Lake commerce. Accordingly, it was deepened to 16 feet in 1881, but the improvement scarcely was completed when the necessity of still greater depth was realized, and in 1896 it was deepened to 21 feet and larger locks put in. Although the Canadian government has built a similar canal, both combined would be incapable of handling the commerce of the near future, for at times they cannot handle promptly existing traffic. A new canal 260 to 300 feet in width, and a new lock 1,350 feet long, 80 feet wide and 24.5 feet deep are now in course of construction on the American side, and a fourth lock has been proposed (Fig. 2.). Other improvements are being made along the Saint

6 Chas. K. Leith: The Mesabi Iron-Bearing District of Minnesota, in *U. S. G. S. Monogr XLIII* (1903), pp. 28-29.

7 John Birkinbine in *Iron Trade Review*, Vol. 58, 1911, p. 51.

8 Dwight E. Woodbridge in *Eng. and Min Journ.*, Vol. 79, 1905, p. 557.

Marys River, and when all are completed 21 feet of water will be available at the lowest stage. President Livingston of the Lake Carriers' Association believes the need of the fourth lock "will be apparent before the third is finished" and that "the time is rapidly approaching when every inch of available space to the international line will be needed for locks."[9]

As late as 1845 one horse hauled all the freight that passed between Lake Huron and Lake Superior.[10] When the canal was

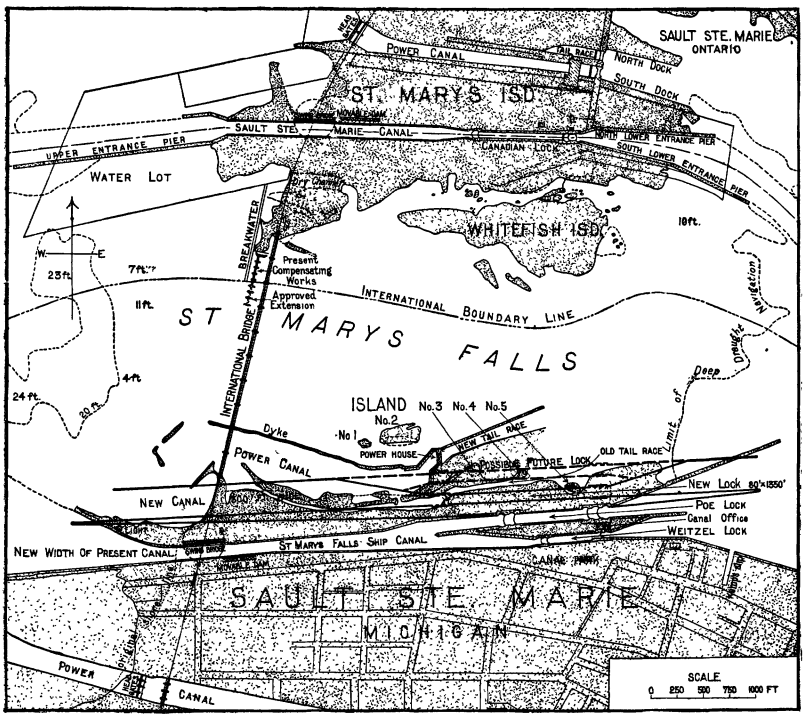

FIG. 2—The Sault Ste. Marie canals, showing new canal and lock now under construction and proposed future lock Scale, 1:23,000. (Compiled from reports of U. S. Army Engineers and hearings of Commission on Rivers and Harbors, House of Representatives.)

opened ten years later the traffic amounted to 14,503 tons a year. The rate of growth was moderate until after the first enlargement of the canal in 1881 (Fig. 3). This gave added impetus to Lake Superior commerce using the canal, and it increased from 1,567,000 tons in 1881 to 16,239,000 tons in 1896, when the second enlargement was

[9] W. Livingston in *The Marine Rev.*, Vol. 41, p. 65.

[10] R. D. Williams: Transportation of Iron Ore on the Great Lakes, *Iron Trade Rev.*, Vol. 48, 1911, p. 548.

completed. After 1896 the commerce increased very rapidly, reaching 62,363,000 tons in 1910. This tonnage is said to be greater than that of the combined commerce of New York, London, Liverpool, and Hamburg.[11] It constitutes 71.9 per cent. of the total domestic commerce of the Great Lakes.[12]

(2) *Growth of Lake Commerce and Relation to Iron Ore.* The commerce of the Great Lakes is (1) largely east-bound; (2) chiefly through traffic, especially between Lakes Superior and Erie; (3) mainly between a few ports, and (4) mostly in iron ore, coal, grain and lumber. Since fully seven-eighths of all Lake commerce passes through Lake Superior, the relation of that commerce to this problem is apparent. Iron ore not only constitutes more than two-thirds of Lake Superior commerce but more than half (53.6%) of the total domestic commerce of the Great Lakes. It is evident, therefore, that the commercial prestige of the Great Lakes depends to-day upon the northern iron mines. This ore must meet the coke of Pennsylvania, West Virginia, and other distant states, hence it forms through, bulk freight, making up 88.2 per cent. of all east-bound traffic and 89.4 per cent. of all iron ore transported on the Great Lakes. It has grown from 1,447 tons in 1855 to 41,603,000 tons in

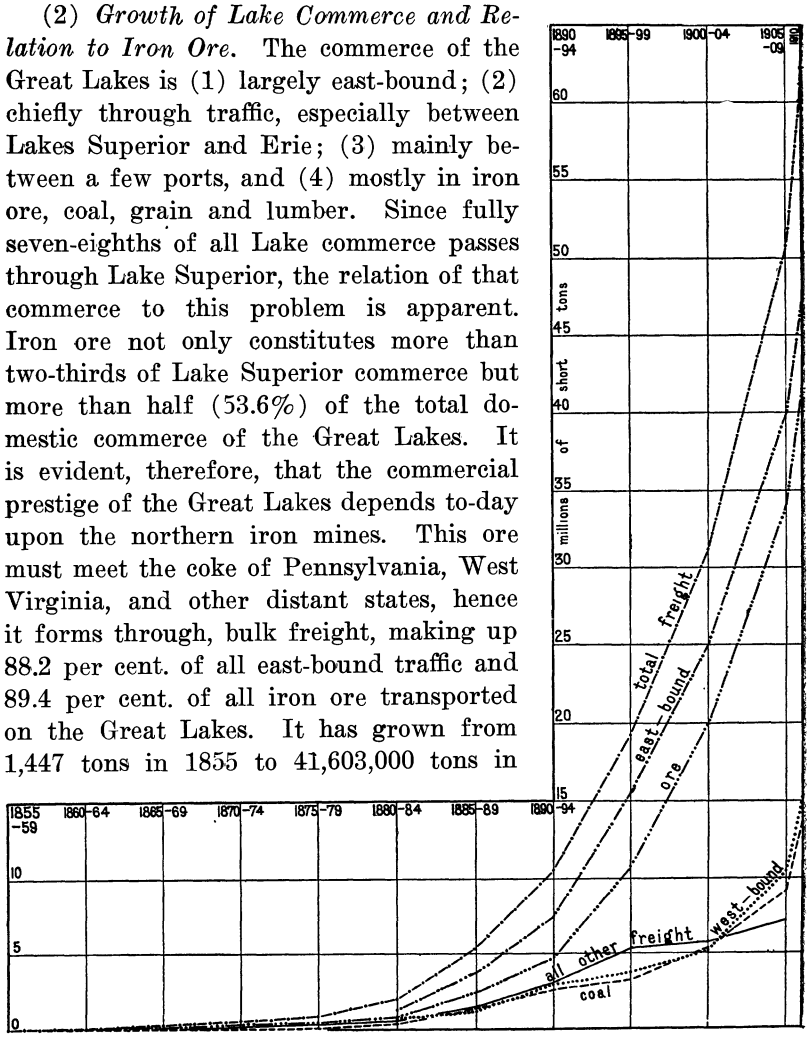

FIG. 3—Freight traffic through St. Marys Falls canals: means of five-year periods.

[11] R. D. Williams: *op. cit.*, p. 548.

[12] Domestic Lake commerce of 1910 was 86,732,316 short tons. (*Monthly Summary of Comm. and Finance*, Dec. 1910, p. 1012.)

1910 (Fig. 3). Grain, flour, and lumber make up all but one per cent. of the remaining east-bound freight. It is also evident that vessels carrying iron ore, grain, and lumber eastward must return empty unless suitable bulk freight can be had. The iron district and an area extending many miles north, west, and south of it, is without coal; hence this commodity forms 88.7 per cent. of the west-bound traffic and more than one-fifth (21.6%) of all freight passing through the Sault Canal (Fig. 3). This coal also makes up 59.8 per cent. of all domestic coal traffic on the Great Lakes. Since there are many ore boats seeking coal as a return cargo, the Northwest gets its coal cheaper than Chicago, the average rate from Ohio ports to Duluth being 31 cents per ton and to Chicago 41 cents.[13] Although cheap coal has done much to hasten development in northern Minnesota, Wisconsin,and Michigan, thus creating a market for other eastern products, west-bound traffic still forms only one-fourth (24.6%) of Lake Superior commerce. The influence of the iron mines on the development of Great Lakes commerce, therefore, has been a controlling one. They have produced traffic in two commodities—iron ore and coal—which together constitute more than four-fifths (88.3%) of the Sault Canal traffic and more than three-fifths (63.5%) of the total domestic commerce of all the Great Lakes. While it is impossible to measure the growth resulting indirectly from this development, it undoubtedly has contributed no small amount to Lake commerce.

(*3*) *Development of the Carrier.* In the development of Lake commerce the canoe was followed by the sail-boat and the latter by the steamer; wooden vessels gave place to steel vessels, and package freight to bulk freight. If considered individually each has been a revolution, but in the course of development one was essentially the corollary of the other. Lake Superior iron ore has been the primary factor in producing the phenomenal changes in recent years. In 1853 there were three or four schooners of 15 to 20 tons burden and two small steamers on Lake Superior.[14] These vessels, with their cargoes, could be put in the hold of a modern ore boat, with room left for a large cargo.

More than half the bulk freighters built in 1896 for Lake Superior traffic exceeded 2,000 tons net register, yet six years before there was not a single vessel of that tonnage.[15] This change was made possible by the Canadian canal and the Poe lock in the Amer-

[13] *Monthly Summary of Comm. and Finance*, Dec. 1910, p. 1064.
[14] R. D. Williams: *op. cit.*, p. 547.
[15] *ibid.*, p. 553.

ican canal. To-day vessels carrying 6,000 tons are becoming obsolete (Fig. 4), while 10,000 to 12,000 ton boats are increasing rapidly in number. Between 1905 and 1909 twenty-six 13,000 to 14,000 ton freighters entered Lake Superior service. During the past twelve years many 400-foot vessels have been replaced by 400 to 600 footers (Fig. 5). With the completion of the improvements now under construction (p. 888), larger vessels may be expected.

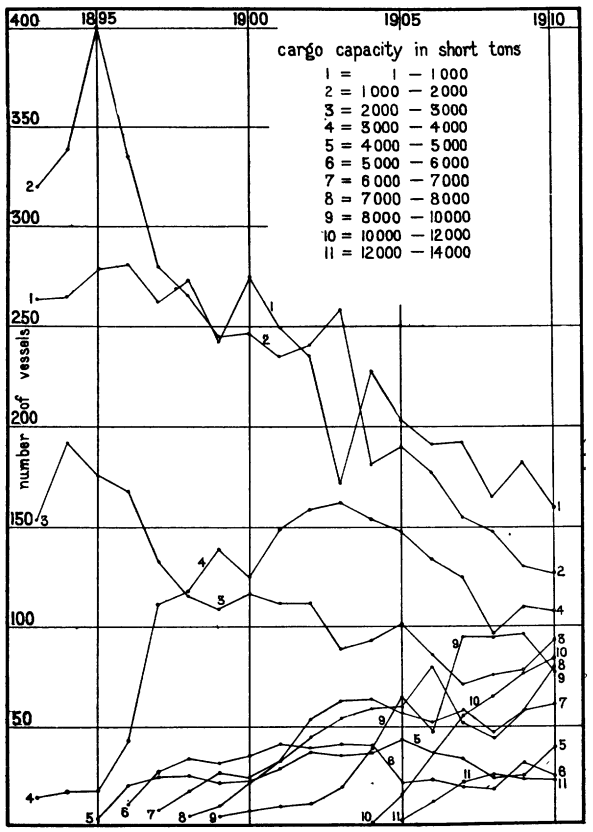

FIG. 4—Change in class of freighters in Lake Superior service on basis of maximum cargo capacity.

In 1910 thirty-eight new freight steamers were put into Lake Superior trade. Fourteen of them do not exceed 258 feet in length, in order to use the Welland Canal; six are between 300 and 500 feet long, and eighteen (42%) are 500 or more feet long and carry from 10,000 to 13,000 short tons of freight in a single cargo.[16] In Janu-

[16] Statistical Report of Lake Commerce Passing Through the Canals at Sault Ste. Marie, 1910, p. 10.

ary, 1911, there were four bulk freighters under construction for American service along the Great Lakes, with a carrying capacity of 460,000 tons a season. Including these, there have been added to the Lake fleet in the past nine years vessels of that class having a combined carrying capacity of 41,548,000 gross tons, an amount nearly equal to the total ore movement of 1909 and 1910. All the bulk freighters building in January, 1911, are for interests identified with iron and steel making.[17] The modern, single-cargo freighter is a direct result of the necessity of transporting a heavy, bulky commodity nearly a thousand miles at a minimum of cost. Bulk freighters exist for carrying grain and lumber, but they serve only a small percentage of the total traffic of the Lakes.

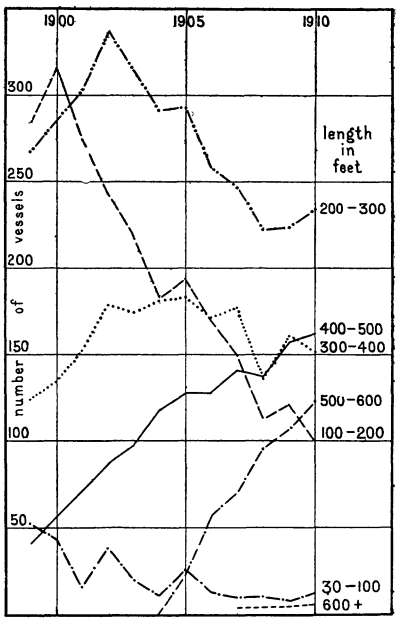

FIG. 5—Change in class of freighters in Lake Superior service on basis of length.

The iron ore traffic has changed not only the size of the carrier, but the carrier itself. Wooden vessels now form only about one-third of the gross tonnage of the Lakes, yet they were dominant a few years since. Steel construction has displaced both iron and wood, and a vessel characteristic of the Lakes has been produced. "They are only square boxes whittled off a little at the ends, and not much forward at that. The reason for this is of course the limited draft of water available and the desire to carry as much as possible on that draft."[18] The machinery is far aft and the pilot house is far forward, leaving all the cargo together and the hatches without a break. The change from sail to steam was accompanied by a change from wood to steel. In 1888 one-third of Lake Superior commerce was carried in sailing vessels; in 1910 only seven per cent. Not a single sailing vessel carrying more than 10,000 tons has ever entered the service.[19]

[17] *Marine Review*, Jan., 1911, p. 1.

[18] W. I. Babcock in *Report of U. S. Commissioner of Corporations on Transportation by Water*, Part I, p. 131.

[19] Statistical Report of Lake Commerce, etc., 1910, p. 10.

(*4*) *Lake Freights.* As the freighters were improved the cost of freight carriage decreased. Since cost of transportation, not mileage, is the true commercial measure of distance, and since steel making affects the whole nation, this change has been of vital importance. In the early 1850's it cost more to get Michigan iron ore

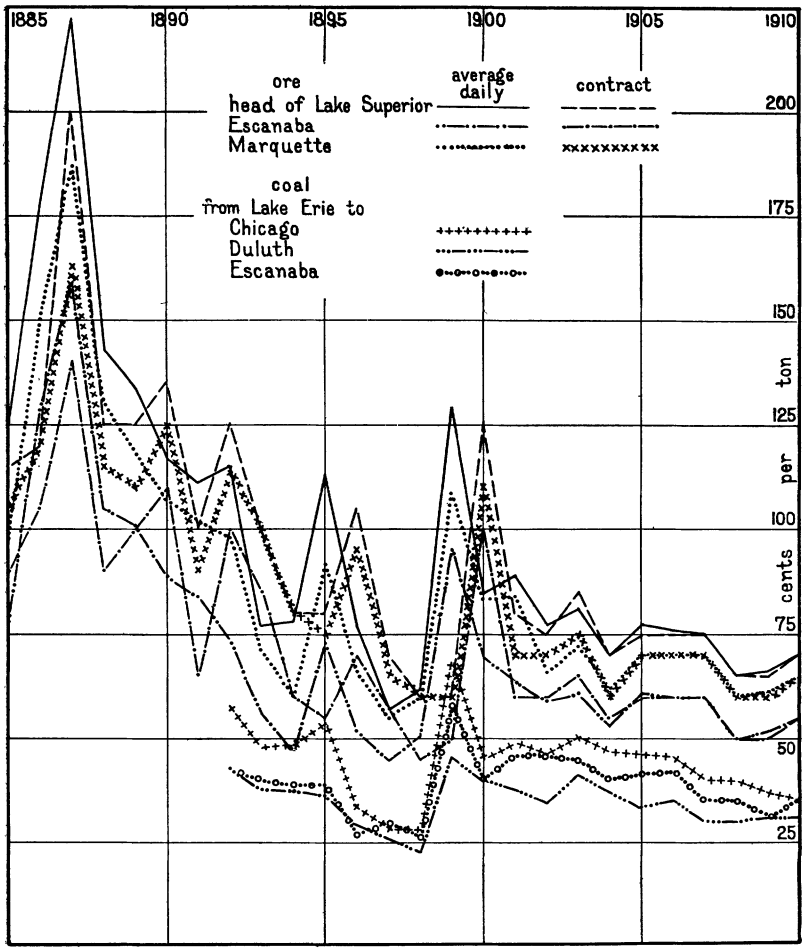

FIG. 6—Average freight rates on iron ore to Ohio ports and on coal from those ports to Chicago, Duluth, and Escanaba.

to the coal than the iron was worth on the market. In 1866 the freight rates to Lake Erie ranged from $3 to $6 per ton, and in 1884 $1.35.[20] The rates since that date are shown graphically in Fig. 6. The change has been characterized by (1) a rapid de-

[20] R. D. Williams: *op. cit.*, p. 552.

cline to 1898, (2) a sharp rise in 1899 and 1900, (3) followed by a decline with little fluctuation. Before 1898 fluctuations were frequent, as steel makers almost always bought ore in the open market, and transportation competition was keen. The next two years witnessed a consolidation and integration of producing and manufacturing companies. The higher efficiency obtained by each of these consolidated companies helped to produce strong competition among them and an increased demand for ore, which resulted in placing ore-carrying contracts early in the season and at high figures (Fig. 6). In 1901 many of these competing consolidations became the United States Steel Corporation, a single subsidiary of which had, in 1909, one hundred ore steamers and barges, carrying one-fourth of the ore moved on the Great Lakes. This is said to be sufficient "to enable it to determine the rates on ore."[21] That there has been some equalizing influence is evident. (Fig. 6).

The ore boats seek coal as a return cargo (page 891), and coal rates fluctuate with those of ore (Fig. 6). Ports at the head of Lake Superior ship most ore, have most returning boats, and secure the lowest coal freights. Duluth receives more than half the coal entering Lake Superior. Lake Michigan ports, except Escanaba, do not ship ore, are not visited by returning ore boats, have poor or no dock facilities for quick handling of coal, and consequently pay higher freights. The water route, steel vessels of great capacity, cheap fuel, coal as a return cargo, the Sault Canal, river and harbor improvements, the growing demand for ore, consolidation of management, and the extensive use of modern machinery, all have contributed toward producing the lowest freight rates in the world for similar service.

Development of Shipping Cities. Two classes of ports—shipping and receiving—have developed with the growth of the iron industry. The former are few; the latter are more numerous and widely distributed. These ports dominate Lake commerce, all but two of the sixteen principal commercial ports belonging to one or the other of these classes. The chief shipping ports are Marquette, Escanaba, Ashland, Two Harbors, and Duluth-Superior (Figs. 7 and 11).

Marquette, the outlet for the Marquette Range, is the oldest ore-shipping port, and for many years was the only one of much importance. Its location was determined by (1) the harbor and (2) proximity to the ore. In 1860 it had a population of only about

[21] Report of U. S. Commissioner of Corporations on the Steel Industry, Part I, 1911, p. 174.

500, but it has become a thriving city with the growth of its ore trade. It installed, in "1858, the first pocket system of ore loading

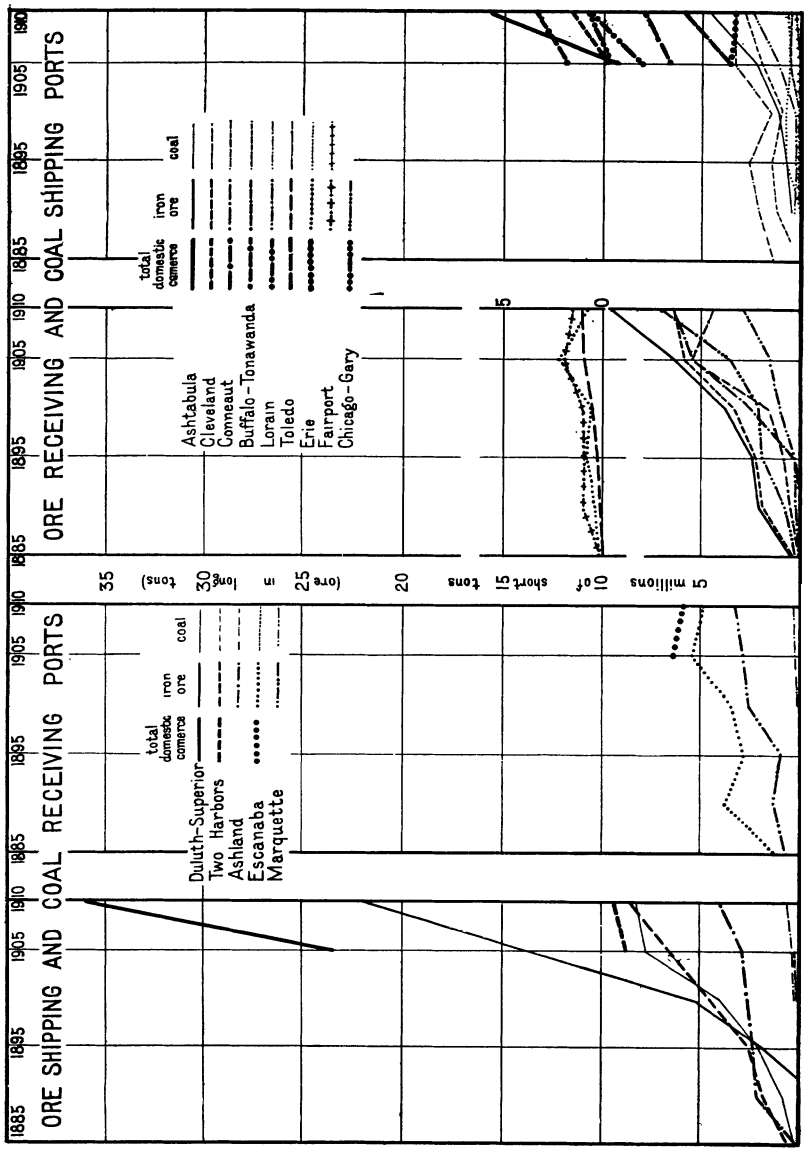

Fig. 7—Commerce of principal iron ore ports.

in the world."[22] The pockets held only a few tons each, but larger and better ones are now in universal use. Its ore shipments have

[22] Report of U. S. Commissioner of Corporations on Water-Borne Traffic, Part II, p. 153.

grown from the few tons of pioneer days to 3,248,000 tons in 1910. Lumber and agricultural interests also have aided in the growth of Marquette.

In 1864 the Chicago and Northwestern Railroad was completed from Negaunee to Escanaba,[23] where an ore dock was built with pockets having a capacity of 20,000 tons, which unload directly into vessels without shoveling. Escanaba has an excellent natural harbor, has a longer season free from ice than Marquette, and is nearer than the Lake Superior ports to the Lake Erie markets, with no canal delays. It therefore became an outlet to the Marquette, Menominee, and Gogebic Ranges, and its shipments soon surpassed those of Marquette, a position which it retains. Although lumbering has been important in the growth of Escanaba, less than one-tenth of its domestic commerce would remain if its ore traffic ceased. This traffic makes it one of the leading Lake ports.

Ashland serves as an outlet for the Penokee-Gogebic Range, especially the Wisconsin portion. Its shipments amounted to 119,000 tons in 1885 and to more than 4,000,000 in 1910. This traffic, like that of Marquette and Escanaba, gives it an abundant supply of cheap coal, which has helped make possible a considerable industrial development.

When the Vermilion Range was opened that portion of the Lake Superior region was a wilderness, and it was necessary to select a harbor and establish a shipping port on the Lake shore. Two Harbors thus came into existence. It was connected with the mines by railroad in 1884, when the first ore was shipped. With the development of the Mesabi Range its ore shipments have grown rapidly, exceeding 8,200,000 tons in 1910. They constitute 99.5 per cent. of its domestic commerce and nearly all of its shipments. Two Harbors has a population of 4,990, an increase of 1,600 in the last ten years. It depends on the ore trade, and its decline would be rapid if that were withdrawn.

Duluth-Superior would have considerable importance without the iron mines. Its strategic position at the head of Lake Superior; its commodious, landlocked harbor of 360 acres, with a minimum depth of 20 feet and 49 miles of frontage; its rich agricultural hinterland, and its water power from Saint Louis Falls are abundant bases for growth. But with iron ore close at hand, cheap coal in large quantity always available, and an increasing market to the south, west, and northwest, its manufacturing advantages are great.

[23] *Collections of Mich. Pioneer and Hist. Soc.*, Vol. 7, p. 169. (Some other writers give this date as 1865.)

Although the lumber and grain businesses have been of much importance in the commercial development of Duluth-Superior, the influence of the mines has been even greater. When the Sault Canal was being built (1854), Duluth-Superior consisted of "one lofty barn-like shed (the hotel), surrounded by an acre of stumps,"[24] and a few hardy pioneers. In 1892 it made its first ore shipment of 4,200 tons and had a population of 45,000. In 1910 it shipped 22,000,000 tons—more than half (51.7%) of all the ore sent by water from all the Lake Superior mines—and its population had increased to 118,800, a gain of 163.5 per cent. in the twenty years. Its ore traffic now forms 67.4 per cent. of its domestic and foreign commerce and more than nine-tenths (91.3%) of its total shipments. Its ore trade is more than half again as large as the total Lake commerce of any other Lake port. Its total commerce equals 58.8 per cent of all that passes the Sault canals, and is equal to about one-sixth of the combined tonnage of all the 240 shipping ports on the coast of the United States.[25] Coal receipts have been a corollary of ore shipments, growing from 592,000 tons in 1885 to 8,420,000 tons, or 62.3 per cent. of all coal entering Lake Superior in 1910. This return trade in cheap coal has been of vital significance in the industrial development of the region.

Development of Receiving Ports: (a) Classification and Importance. The iron ore shipping ports are few in number, but the receiving ports are numerous and widely distributed along the Lakes (Figs. 7 and 11). These ports may be classified as (1) manufacturing and distributing and (2) distributing only. To the first class belong Cleveland, Erie, Buffalo-Tonawanda,[26] Chicago-Gary, Toledo, and Lorain, and to the second class Ashtabula, Conneaut, and Fairport. There are numerous other minor ports belonging to the manufacturing class, the aggregate receipts of which are large, but which need not be considered here. The total domestic commerce of the nine or ten ports named constitutes (1910) nine-tenths (89.6%) of the total domestic commerce of the five Great Lakes. The domestic commerce of the eight Lake Erie ports formed more than nine-tenths (92.4%) of the total for that lake, and their receipts formed nearly half (44%) of the total receipts. The position they occupy in Lake commerce is, therefore, one of great importance. The factors determining their relative importance in the ore and

[24] Laurence Oliphant: Minnesota and the Great West (1855), p. 145.

[25] James O. Curwood: The Great Lakes (1909), p. 119.

[26] For convenience the ports of Buffalo and Tonawanda, of Chicago and Gary are grouped as single ports, as representative of the chief ore ports at the lower ends of Lakes Erie and Michigan.

coal traffic, and hence in Lake commerce, are many and variable. Among the fundamental ones are (1) policies of railroads and interests of those controlling railroads serving these ports, (2) location of new manufacturing plants and the improvement of old ones, and (3) harbor advantages.[27]

(*b*) *Manufacturing and Distributing Ports.* Only the commercial phase of the manufacturing problem will be considered here. Cleveland, Chicago-Gary, Buffalo-Tonawanda are the leaders of this group. Cleveland was at one time the most important receiving port. It is served by more railroads than its rival—Ashtabula—but it has poorer harbor facilities, as boats must dock in the river. It has the advantage, however, of being a large ore consumer, and consequently its receipts have grown rapidly from 589,000 tons in 1885 to 6.3 million tons in 1910. Many things have contributed to the growth of Cleveland, but it was the development of the Lake trade which made it a great industrial center. Only a few years ago this trade "was considered of little importance and a few broken-down steamers were sufficient" to meet requirements.[28] In 1910 the ore trade equaled more than six-tenths of Cleveland's entire domestic Lake commerce and nine-tenths (88.9%) of its total receipts. Cleveland is also an important coal-shipping point, and that commodity forms more than four-fifths of its out-going freight.

Buffalo and Tonawanda occupy strategic positions at the head of Lake Erie, have power for manufacturing equaled by few other American cities, and are certain of a prosperous growth without the iron and steel industry. Yet this district has the largest independent steel-making plant in the United States, and its ore traffic has grown in twenty-five years from 7,160 tons to 4.3 million tons. Some of this ore is sent farther inland, but most of it is consumed at the ports. It enjoys a large trade in grain as well as in coal and iron ore, yet the last two formed more than three-fifths (61%) of its total domestic commerce in 1910, coal making up 70.4 per cent. of the shipments and iron ore 56 per cent. of the receipts. It ships nearly 2.5 million tons more hard coal than all the other Lake ports combined. Until 1905 Lorain was its closest ore-receiving competitor, but, owing to the construction of two new plants and the addition of several stacks to old plants, its ore receipts since then have increased faster than those of any other port (Fig. 7). The commerce of Lorain is almost entirely (97.5%) ore and coal.

[27] Report of U. S. Commissioner of Corporations on Transportation by Water, Part II, p. 158.

[28] W. F. Gephart: Transportation and Industrial Development in the Middle West (1909), p. 257.

Erie and Toledo have one and two furnaces, respectively, and are of relatively small importance, yet ore and coal dominate the Lake commerce of both. The ore receipts of the former were 938,000 tons in 1910, and with coal (696,000 tons) constituted three-fourths of its Lake traffic. The ore traffic of the latter formed more than four-fifths (84.3%) of its total receipts. It is the second largest coal-shipping port on the Lakes, that commodity making up 95.3 per cent. of its shipments.

Chicago, Gary, and Milwaukee are the only important ore-receiving ports on Lake Michigan. They are almost exclusively manufacturing points, so far as iron ore is concerned. The Chicago-Gary region occupies a strategic position near the head of the Lake, has excellent land transportation to a rapidly growing market, is near coal and limestone, and its ore receipts have grown from 260,700 tons in 1885 to 6.8 million tons in 1910. Nearly 50 per cent. of this increase has occurred in the last five years. Owing to the methods of railroad companies, legitimate and otherwise, the Lake commerce of this district is not commensurate with its advantages. If its ore traffic were to cease it would lose 56.8 per cent. of its total Lake commerce and would retain less than one-third (30.4%) of its receipts by water. These facts emphasize the importance of the Lake Superior ores to the Chicago-Gary region.

(*c*) *Distributing Ports.* Ashtabula is the largest ore-receiving and coal-shipping port in America, and probably in the world. It receives ore for distribution only, and the growth of its receipts in twenty-five years, from 582,000 tons to 9.6 million tons, is, therefore, all the more remarkable. Ore forms almost all (99.9%) of its receipts and coal more than nine-tenths (93.5%) of its shipments. It has excellent rail connections with the coal and smelting districts of western Pennsylvania and eastern Ohio and harbor facilities unexcelled by any of its competitors. The harbor advantages have given it prestige.[29] Without ore and coal, Ashtabula probably would become an insignificant village.

Conneaut, like Ashtabula, Fairport, and Huron, is a distributing point, and exists largely or wholly because of the ore which comes from the Lake Superior mines. It has good harbor facilities and is the terminus of the Bessemer and Lake Erie Railroad, controlled by the United States Steel Corporation. Since that corporation is the largest shipper of ore, Conneaut rose in ten years from an insignificant place to the third largest receiving port on

[29] Report of U. S. Commissioner of Corporations on Transportation by Water, Part II, p. 159.

the lakes. In 1895 it received about 200,000 tons, ten years later more than five and one-quarter million tons, and in 1910 6.3 million tons. The last constituted nine-tenths (91.7%) of its total commerce, and nearly all of its receipts.

Fairport has a good harbor, and the Baltimore and Ohio Railroad connects it with the Youngstown-Pittsburg district. Its ore receipts and relatively small coal shipments form three-fourths (75.3%) of its commerce.

Settlement of the Lake Superior Region: (a) Settlement of Area and Increase in Population Due to Mines. Until 1850 the settle-

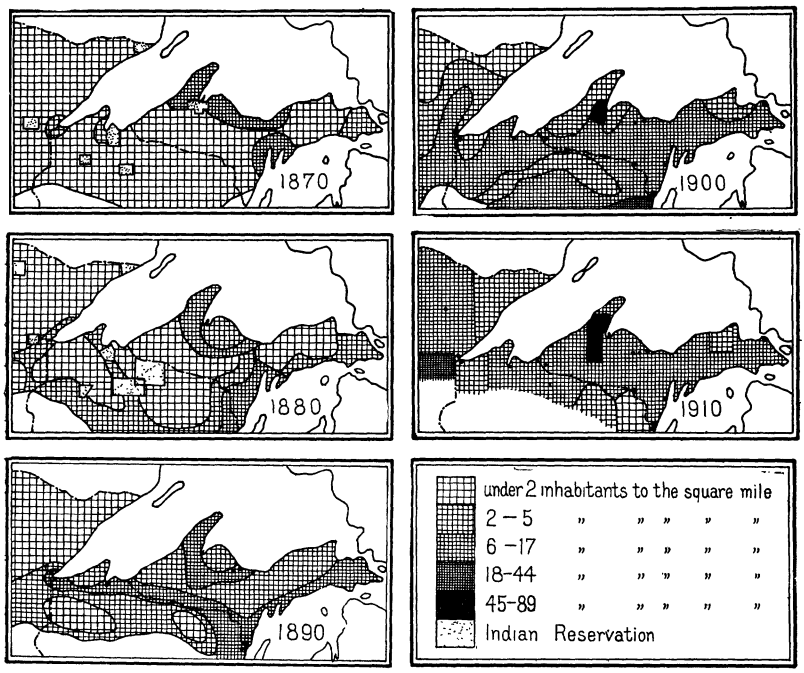

FIG. 8—Distribution of population in the Lake Superior iron mining region, 1870 to 1910.

ment of the Lake Superior region was confined to Sault Ste. Marie, the copper mines in Houghton County, and a few pioneers at Ontonagon and near Ashland. The opening of the Sault Canal in 1855 began a new era, as the bulky iron ore was afforded an outlet. Progress, however, was relatively slow until the Civil War created a demand for iron and stimulated mining. This gave Marquette County the advantage over all others, except Houghton, whose copper mines have been equally important in its settlement and progress. During the thirty years following 1860 the population

of Marquette County increased from 2800 to 39,500, or more than 1300 per cent (Fig. 9). Since 1890 it has had strong competitors, and the loss of territory to other counties has made its growth less conspicuous.

The completion of a railroad to Escanaba in 1864 and the opening of the Menominee Range in 1877 led to rapid settlement in the southern portion of the peninsula (Figs. 8 and 9). This range did not become a steady and important producer until ten years later (Fig. 1), but acquired a population of about 5,000 by 1880, which more than doubled by 1890, and increased more than 500 per cent. by 1900 (Fig. 9).

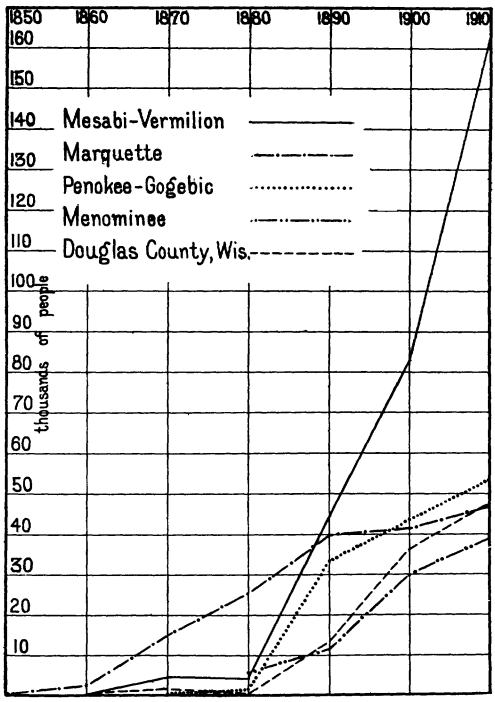

FIG. 9—Growth of population in Lake Superior district by iron range counties, 1850 to 1910.

The Penokee-Gogebic district was essentially a wilderness until the first mine was opened in 1884 (Fig. 1). Four years before its population did not exceed 1,600. Six years later (1890) it had increased more than twenty-two times (2031.4%), and it has had an average annual growth of 1,000 people ever since.

The Mesabi-Vermilion region has been settled with great rapidity (Fig. 9). By 1880 about 4,500 people had been attracted to the head of the Lake and were settled on St. Louis Bay and along the St. Louis River, more than half of them being in Duluth. Carlton County and the adjoining portion of Wisconsin had less than 2,000 more. The back country was untouched except by trappers and explorers, but the opening of the Vermilion Range in 1884 and the great Mesabi deposits in 1892 induced a phenomenal growth and checked the settlement of the other ore districts (Fig. 9, 1890). By 1890 the population of the Mesabi-Vermilion region had increased to nearly ten times that of

1880; by 1900, 1741.1 per cent., and by 1910 nearly 30 times, or 3525 per cent. Douglas County, Wisconsin, might be included with this district, since its growth is due to the development of the Mesabi-Vermilion ranges, and since it contains Superior, one of the largest ore-shipping and coal-receiving ports on the Lake. Just before mining operations began the population of the county was about 650 (Fig. 9), but since then it has increased more than seventy times, more than 85 per cent. of which is in the city of Superior.

Duluth and Superior lead all the other Lake Superior ore centers in their growth, diversified interests and possibilities. Nearly all the industries of these cities are based on things other than iron and steel. Lack of coal not dependent upon returning ore boats and distance from market have been serious handicaps to the economical utilization of their greatest resource—iron ore. However, the rapid development of a market in the northwest and the opportunity to convert cheap return-cargo coal into coke in the modern retort oven and have the by-products share, if not pay the entire cost, have encouraged the building of a large steel plant at Duluth. More than 1.7 million dollars were expended in construction during 1910, and further work is in progress. When completed, the plant will include "two blast furnaces, seven open-hearth steel, and one 10-inch blooming mill, one 28-inch and 18-inch rail and bar mill, 16-, 12-, and 8- merchant mill,"[30] and ninety by-product coke ovens, together with power plants, pumping stations, machine shops, etc.

(*b*) *Two Classes of Towns Developed.* Aside from the rural communities and the many small, unincorporated villages, two distinct classes of towns and cities have grown up during this rapid settlement, viz., mining and shipping towns. A cluster of houses and stores soon followed the opening of mines, and upon the latter the prosperity of the village depended. To this group belong such places as Hibbing, Virginia, Ely, Tower, Missabi, Ironwood (containing nearly half the population of the county), Bessemer, Iron Mountain, Ishpeming, and Negaunee. Some of these have developed related local industries and are thriving little cities. In the last ten years six new towns were incorporated in the Mesabi-Vermilion region, with a total population of 12,699. To the second class belong Marquette, Escanaba, Ashland, Two Harbors, and Duluth-Superior, which have been discussed.

[30] W. R. Ingalls: Mineral Industry (1910), p. 380.

Lake Superior Ores and the Steel Industry.

Relation of Superior Ores to the Steel Industry. Previous to 1860 Lake Superior mines furnished less than three per cent. of the iron ore produced in the United States. New York, New Jersey, Pennsylvania, and Ohio were the leading iron producers, and in 1880 they supplied three-fifths (59.5%) of the total. Four years later the estimated ore consumption of the United States was twice the production of the nine leading iron ore districts, showing the widespread use of local ores by the blast furnaces.[31] Concentration in iron manufacturing, high-grade Superior ores, and cheap Lake

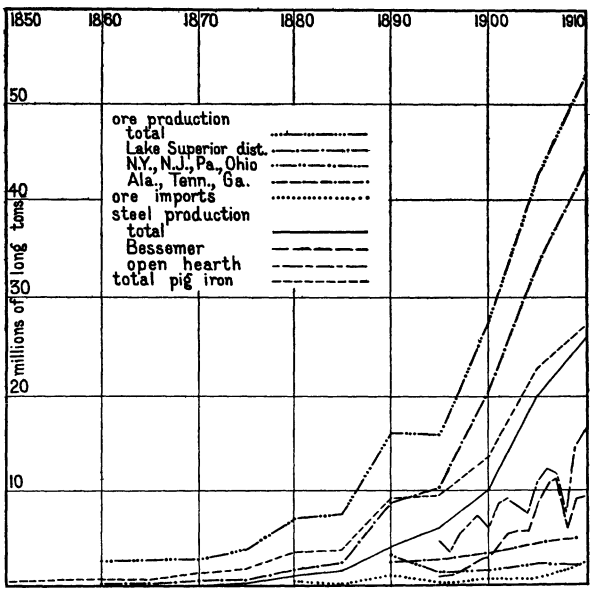

Fig. 10—Iron ore and steel production of the United States.

transportation had not become of sufficient importance to close the small mines serving local markets, many of which have been abandoned since. In 1885 the price of pig iron and steel rails fell to $18 and $28.50 respectively (Fig. 12). The industry now ceased to be local and "followed the line of least cost in bringing together the raw materials of manufacture, the principal one of which was iron ore."[32] The value of Superior ores was unquestioned, and by 1890 they formed 55.7 per cent. of the total iron ore product

[31] Iron and Steel Trade of the United States, in *Monthly Summary of Comm. and Finance*, Aug., 1900, p. 206.

[32] *ibid.*, p. 207.

of the United States, and in 1910 81.5 per cent. At the same time the combined output of New York, Pennsylvania, New Jersey, and Ohio declined from 20.4 per cent. of the total to 4.5 per cent., and that of Alabama, Georgia, and Tennessee from 16.3 per cent. to 10.3 per cent (Fig. 10).

Destination of Lake Superior Ores. Only a small quantity of Lake ores is consumed in local blast furnaces, and since they form more than four-fifths of the total production of the country, have

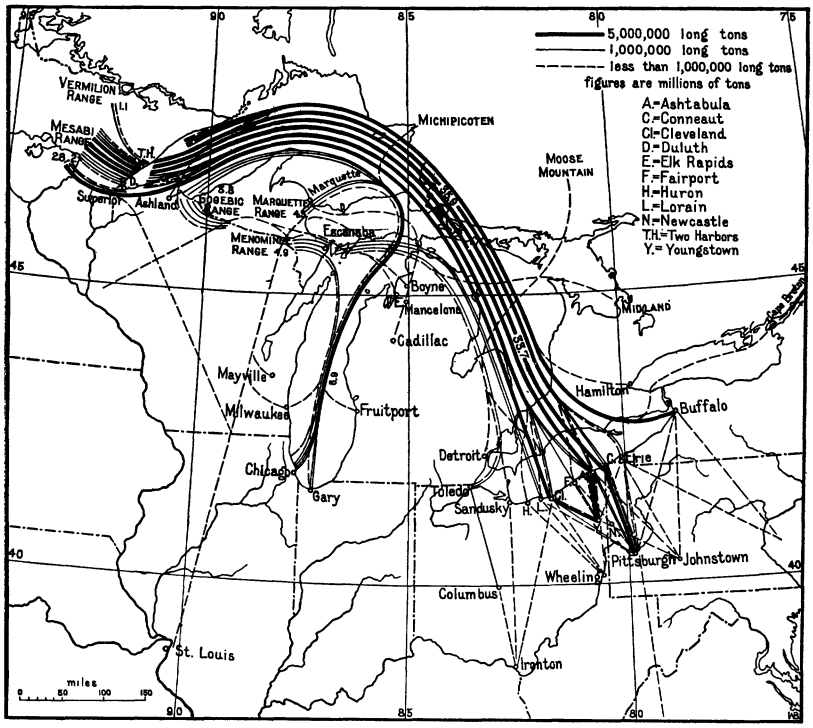

FIG. 11—Destination of iron ores of the Lake Superior region, 1909. (After Birkinbine.) Scale, 1:14,500,000.

cheap Lake transportation, and are handled by the best appliances for loading and unloading from car to vessel, and vice versa, they can be carried great distances (Fig. 11). After passing the Sault Canal about one-seventh of the ore enters Lake Michigan, and nearly all the balance, or approximately 30,000,000 long tons, goes to Lake Erie ports. From these ports most of it is carried to the Youngstown-Pittsburg district. Millions of tons are carried several hundred miles further, however, to eastern Pennslyvania, Virginia,

and Ohio River points, and for special purposes to New England. In addition to water-borne ore, considerable quantities are shipped by rail to furnaces within convenient distances from the mines and to points to which an all-rail haul is more economical than breaking bulk from vessels. Such points are St. Louis, Missouri, and Mayville, Wisconsin (Fig. 11).

Influence in Locating Steel Plants and Allied Industries: (a) Movement to Pittsburg District. The production of iron and steel may be divided into three quite distinct periods on the basis of fuel used, viz., charcoal, anthracite, and coke. Previous to 1855 charcoal was dominant, and furnaces were scattered widely to meet local needs, as in the case of the old saw and grist mills. Between 1855 and 1875 anthracite led. Since a small area in northeastern Pennsylvania had all the fuel, was able to make large quantities of iron, and was near the New York and Philadelphia markets, the first opportunity for leadership in the American iron industry was offered and the first great producing center was established here. In 1870 half of all the pig iron was made with anthracite, but by 1910 this had declined to 2.4 per cent.

By 1875 the greater efficiency in this industry of bituminous coal and coke had been demonstrated. The most important supply of coal and coke lay west of the Appalachians, as did the iron ore and limestone, hence before 1880 the industry had shifted to western Pennsylvania. The introduction of the Bessemer process led to rapid development, and by 1880 the best local ores had been used. Nearness to Lake Erie and cheap Lake transportation made it impossible for the lean ores of western Pennsylvania to compete with the high-grade ores from Lake Superior, hence by 1883 western Pennsylvania produced more pig iron than any other district in the United States.[33] Pittsburg could not avoid becoming an iron and steel center. It commanded Lake ores and coke from nearby centers, had good transportation facilities by water and rail, natural gas, an established eastern market, a rapidly growing interior market, and a local market produced by the growth of allied industries. For almost a half century these advantages have made Pennsylvania the leading iron and steel-making state. In 1910 Allegheny County alone made 19.5 per cent. of the pig iron product of the country; 27.3 per cent. of all steel ingots and castings; 41.9 per cent. of the total structural shapes; 27 per cent. of the country's plates and sheets; and 26.2 per cent. of the rolled iron and steel

[33] James M. Swank: Manufacture of Iron in All Ages, p. 231.

of the United States. Without the Lake Superior ores its leadership would be lost at once.

(*b*) *Movement to Lake Shores.* That the Pittsburg district is destined to lose its relative position seems certain. In 1890 Allegheny County made 14.5 per cent. of the pig iron product of the

PIG IRON PRODUCTION IN PERCENTAGE OF TOTAL FOR THE UNITED STATES[34]

YEAR	ALABAMA DISTRICT	ATLANTIC COAST	LAKE SHORES	ALLEGHENY CO., PA.	ALL OTHERS
1890.....	12.1	22.6	14.4	14.5	36.4
1895.....	12.0	....	15.7	....	....
1899.....	10.6	13.0	15.9	23.9	36.6
1901.....	10.0	13.3	16.8	23.2	36.7
1902.....	10.7	11.6	16.8	23.9	37.0
1903.....	11.4	12.4	17.1	23.4	35.7
1904.....	11.1	11.0	18.0	26.6	33.3
1905.....	8.8	10.8	19.7	23.5	37.2
1906.....	8.6	11.1	20.5	22.5	37.3
1907.....	8.3	11.3	22.4	21.1	36.9
1908.....	10.7	9.9	24.9	24.5	30.0
1909.....	....	....	....	21.3	....
1910.....	....	....	....	19.5	....

United States, and the Lake shores made 14.4 per cent. In the following eighteen years the product of Allegheny County furnaces increased irregularly to 24.5 per cent., but two years later (1910) it declined to 19.5 per cent. During the same time the Lake shore product increased without fluctuation to 24.9 per cent. (1908), thereby becoming the leader. Further evidence of this lakeward tendency is found in the selection of Buffalo by the Lackawanna Iron and Steel Company for its new works.[35]

Obviously there are certain fundamental factors operating to determine the location of iron and steel works. (1) In general two tons of ore are required for one ton of iron, and two to two and one-half tons of ore to one ton of coke. This ratio is increasing with the use of leaner ores. This would seem to indicate that steel plants should be near the iron ore mines. However, present means of shipment and handling make ore transport cheap, and it deteriorates very little in handling; hence the ore can travel much farther than the fuel. (2) The fuel, mostly coal and coke, is less easy to transport than ore, for it is more bulky and deteriorates with handling. It is, however, absolutely necessary in ore reduc-

[34] John J. Porter in *Manufacturers' Record*, Oct. 7, 1909, p. 59.
[35] Andrew Carnegie: The Empire of Business, p. 238.

tion and steel making; hence plants are located where there is abundant mineral fuel at a convenient distance. (3) Labor is mobile and at present goes where work is offered. (4) An easily accessible market, where the product can be converted rapidly and regularly into money, is vital, and plants remote from a market are seldom successful.

Several points along the shores of the Great Lakes possess all the advantages. More than three-fourths of all the known available iron ores of the United States and nearly all the highest grade ore is directly tributary to these ports at a transportation cost of 50 to 70 cents per gross ton.

The fuel problem is even more promising. About two and one-half tons of ore can be secured at a freight rate slightly, if any, higher than that for the necessary one ton of coke. But the process of making coke is changing, and for this reason coal instead of coke will be shipped to the steel-making Lake ports. New retort ovens are being installed in connection with the steel plants, the gas from which will supply power and fuel for the plants themselves, while the sale of surplus gas and other by-products will more than pay the coal freight. In some cases at least Indiana and Illinois coal will be used, thus eliminating the long haul from Connelsville and West Virginia. Retort ovens with by-product recovery attachments are now in operation in Milwaukee, Chicago, Gary, Buffalo, Cleveland, and other cities.

A local supply of labor is no longer important. This is shown clearly by the transforming, within four years, of a desolate sand dune area to a thriving city of over 30,000 at Gary, Indiana.

The Lake ports engaged in the iron and steel industry have excellent markets in the large and rapidly developing Mississippi Basin to supplement the demand created near their steel plants by allied industries and building trades. They also have the advantage of both water and rail transportation direct from the steel mills. This, for example, enables the products of the South Chicago and Gary plants to reach its foreign market entirely by the water route, and at the same time affords it rapid rail transportation to the central part of the country.

(*c*) *Allied Industries and City Development.* Since iron is fundamental to all manufacturing industry, the location and success of large steel plants are of vital significance in city growth. Iron and steel enters so completely into other industries "that prosperity in any of them increases the demand for iron entering as material into

their products, and at the same time also increases the demand for machinery and tools for working up that material into finished products."[36] Because of this intimate relation, the iron and steel industry forms an accurate barometer of the general condition of all industrial business. The building of a large steel plant immediately attracts other manufacturing enterprises dependent upon a cheap and regular supply of raw steel and pig. This means the concentration of thousands of laborers, the development of mercantile pursuits to supply the market thus created, and hence the rapid growth of cities. Lake Superior ores are and for many years will be a chief factor in the growth of many cities. Without these ores Pittsburg would be a much less thriving manufacturing city. Youngstown and neighboring cities, Wheeling, Steubenville, Johnstown, and other important places "would support but a small fraction of their present industries and population, notwithstanding the advantages of local fuel or river transportation which they have."[37] Much of the advancement of Buffalo, Duluth, Ashland, Marquette, Escanaba, Chicago, Milwaukee, Cleveland, Toledo, and Detroit is due to the same powerful agency, while Gary, Lorain, Ashtabula, Conneaut, and Tonawanda are creations of it.[37]

A Factor in Formation of Large Corporations. Ever since the Lake Superior ore became dominant in the iron and steel business there has been an invitation to consolidation. The chief factors favoring this were (1) the localization of more than nine-tenths of the known iron ore reserves of the United States within a limited area; (2) the possibility of controlling freight rates on ore from mine to smelter, and on coke to the smelter; (3) the localization of the best coking coal in the Pennsylvania-West Virginia-Kentucky district; and (4) the unparalleled opportunity for stock speculation.

Previous to 1898 the steel industry was characterized by active competition and very slight integration between the producing of the raw material and the finished product. By the beginning of 1900 the business had been revolutionized. One consolidation had followed another until less than a dozen controlled the business. One group of consolidations controlled the manufacture of crude and semi-finished steel for the general trade, "or of the heavier finished steel products, such as steel rails, beams, plates, and bars";[38] the other group controlled the tin plate, wire, wire nail, wrought and seamless tubing, steel sheet, and the heavy steel bridge construction

[36] Twelfth Census: Manufactures, Vol 1, p. cxlix.
[37] John Birkinbine in *Iron Trade Review*, Vol. 48, 1911, pp. 51-52.
[38] Report of U. S. Commissioner of Corporations on the Steel Industry (1911), Part I, p. 4.

industries. These individual consolidations were, or soon became, completely integrated units, that is, their operations extended from the ore mine to the finished products. It became apparent that their life depended upon the control of large ore reserves, hence the larger proportion of the Lake Superior ores were soon secured "by less than a dozen interests, chiefly steel-making concerns. The most desirable coking coal fields of the East had been secured, largely by the same steel making interests, with almost equal rapidity."[39] The *immediate* causes producing these consolidations were (1) a desire to restrict the competition which previously had characterized the industry; (2) a desire to bring about complete integration between raw materials, transportation, and manufacturing processes, thus introducing great economies; and (3) a desire to create a great amount of inflated securities.[40] This was accomplished by issuing common stock as bonus for each share of stock turned in to the consolidation. For example, each $100 share of the Consolidated Steel and Wire Company grew to $490 by the time that concern, by a series of consolidations, became a part of the American Steel and Wire Company of New Jersey. This amount was increased further when the latter company became a part of the United States Steel Corporation.[41]

Each of the consolidations was essentially independent of the other, integration brought the economies expected, and each was better able than ever to meet competition. Essential monopoly was secured in some branches of the industry, but competition was not destroyed, and threatened to become more severe than ever. Continued strong competition between these powerful groups would mean overproduction and serious industrial disturbance. It was believed that the situation would be controlled completely if these great groups could be united with each other and with the Lake Superior Consolidated Iron Mines Company, which controlled several hundred million tons of high-grade ore, a railroad to the shipping ports, and a fleet of ore vessels. The opportunity to eliminate competition, secure integration, and inflate steel stocks was unprecedented, and in 1901 the United States Steel Corporation was formed.

By this combination the corporation acquired about 700,000,000 tons of Lake Superior ore, more than 50,000 acres of coking coal lands, several railroads with more than 1,000 miles of track, a fleet of 112 ore vessels, steel works with a yearly capacity of more

[39] Report of U. S. Commissioner of Corporations on the Steel Industry (1911), Part I, p. 5.
[40] *ibid.*, p. 5. [41] *ibid.*, p. 6.

than 9,400,000 tons of crude steel and more than 7,700,000 tons of finished rolled steel products,[42] about two-thirds of the steel ingots production, one-half to four-fifths of the rolled steel products, and about 58 per cent. of the steel-making pig-iron production of the United States.[43] Since then it has made extensive additions to its holdings, and in 1910 it controlled about 1.6 billion tons of ore, or more than 75 per cent. of the commercially available Lake ore reserves.[44] It is because of these ore holdings and "the peculiar advantages enjoyed in the transportation of ore that the Steel Corporation occupies an extremely commanding position in the iron and steel industry. Indeed, in so far as the Steel Corporation's position in the entire iron and steel industry is of monopolistic character it is chiefly through its control of ore holdings and the transportation of ore."[45]

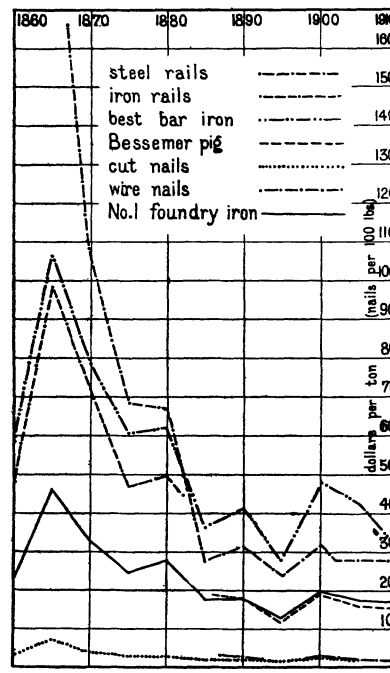

FIG. 12.—Prices of selected iron and steel products for fifty years, 1860 to 1910.

Relation to Prices of Steel Products. During the past half century there has been much fluctuation in the prices of leading iron products (Fig. 12). The Civil War, together with depreciated money values, active competition among both ore producers and manufacturers, and periods of business depression and activity, have been contributing causes. During the same period there has been a substantial absolute decline produced by the Bessemer and open-hearth process, improvements in blast furnaces, manufacturing processes, ore transportation and handling methods, consolidation and integration, and the use of Lake ores. As has been shown, an ore supply is fundamental to the steel industry, and its cost is equally fundamental in determining the manufacturing cost of iron and steel products. Monopoly in some branches determines the sell-

[42] Report of U. S. Commissioner of Corporations on the Steel Industry (1911), Part I, p. 13.
[43] *ibid.*, p. 12. [44] *ibid.*, p. 58. [45] *ibid.*, p. 60.

ing price. True ore values are determined primarily by the estimate that the consumer places on the resulting manufactured products of iron and steel. Until recently Bessemer steel dominated the business, and ore of almost perfect Bessemer grade was available in large quantities and at small cost in the Michigan and Minnesota mines. It is natural, therefore, that these ores should dominate the market and constitute the largest single factor in fixing the low price of ore and hence in cheapening the cost of manufacture and in lessening the price to the ultimate consumer.

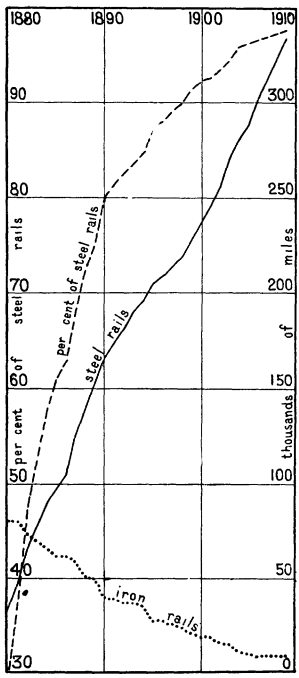

FIG. 13—Change in iron and steel railway mileage in the United States, 1880 to 1909.

Relation to Railway Expansion: (*a*) *Lake Ores Basic Factor in Change to Steel Rails.* The first Bessemer steel rails rolled in the United States were produced in Chicago in 1865. The market price of steel rails three years later was $166 per ton (Fig. 12). This price declined rapidly to $67.52 in 1880. Their value was realized, but they cost more than iron rails, and in 1880 the latter still formed more than four-fifths (81%) of the total railway mileage (Fig. 13). In less than three years, however, the price of steel rails fell below that for iron rails, and the latter ceased to be quoted (1882) on the market. From that time on iron railway mileage decreased, and steel mileage increased rapidly, forming 97.7 per cent. of the total mileage in 1909 (Fig. 13). This change was due to (1) the Bessemer process, (2) the supply of suitable Lake ores, and (3) the superiority of steel rails. Without either it would have been slow and costly. In 1907 93 per cent. of the rails produced were Bessemer, but since then open-hearth rails have increased to more than 47 per cent (1910) of the yearly output.[46] This proportion will increase as better rails are secured and as poorer ores can be used in the open-hearth process.

(*b*) *Railway Efficiency Increased.* The substitution of steel for iron rails was "the primary factor in the improvement of American

[46] W. R. Ingalls in *Mining Industry*, Vol. 19, 1910, p. 366.

railroad service," and but for this change "none of the other" improvements "would have been possible. This increase in the use and size of steel rails . . . has induced the other improvements."[47] Since steel rails are eight to fifteen times more durable and much stronger than iron rails, the size of locomotives, cars, and train loads has been increased greatly. At the close of the Civil War the average engine weighed 90,000 pounds; by 1900 it weighed 250,000 pounds. Its average freight-carrying efficiency increased 50 per cent. in the five years from 1894 to 1899.[48] At the beginning of the same period (close of the Civil War) the average freight car carried seven and one-half tons; in 1900 it carried fifty tons. In the latter year a car of forty-ton capacity could be constructed weighing only 3,000 pounds more than a thirty-ton car "and cost hardly $50 more."[48]

(*c*) *Spread of Population and Industrial Development Encouraged.* Rapid railroad growth has been fundamental in the expansion of population and in industrial development. Under our free-land policy population spread westward with extraordinary rapidity, and for a time it was essentially a race between the westward extension of settlement and the railroad, the latter endeavoring to serve the former. Cheap and high grade Lake ores supplied the steel essential to this expansion. The old iron equipment was wholly inadequate in either strength or endurance. It seems certain that the settlement and economic development of the West and of much of the central plains would have been delayed but for these ores and their proximity to the Great Lakes.

Railroads opened up the fertile lands of the West and Northwest and were primary agencies in the successive westward movement of the wheat region. They made it possible for these new lands to compete with the older grain districts of the eastern states, of Europe, and of Asia. "The immense agricultural crops of the country . . . never could have been moved to either home or foreign markets if iron rails had continued in use; the attempt to transport them . . . would have so worn out the rails that the tracks would have been continually torn up for repairs," resulting in constant interruption of traffic. Dependence upon foreign steel rails would have so increased the transportation cost "that it would not have been profitable to grow these immense crops; indeed the prices of foreign rails would have been so high that few railroads would have been built in the western states and territories, and the marvelous

[47] Final Report of the U. S. Industrial Commission, 1902, p. 291.
[48] *ibid.*, p. 293.

development of that section could not have taken place . . . But for our cheap home-made steel rails, flour and meat, lumber and coal and other heavy products could not have been cheaply distributed to consumers; the necessaries of life would have been largely enhanced in price through the high cost of transportation, and the whole country would have had a much less rapid growth than it has experienced."[49]

Relation of Lake Ores to Position of United States in World's Iron and Steel Business

Lake ores not only hastened the development of the interior United States and aided in determining the character of this development, but were fundamental in making America the world's greatest iron and steel producer. Forty years ago (1870) the United Kingdom led all other countries, producing half of the world's pig iron and more than two-fifths of the steel. The United States was a poor second, making only 13.8 per cent. and 9.6 per cent. respectively. Both Germany and France were larger producers of steel than the United States. During the eighties Lake ores and the Bessemer process became established in the American steel industry, and by 1890 the United States surpassed all it rivals (Fig. 14). That year the United States produced more than one-third of the world's pig iron and steel, the United Kingdom about three-tenths, and Germany about four twenty-fifths. Since then the development of the basic process has made available Germany's extensive ore resources, and by 1902 its output exceeded that of the United Kingdom. Germany's growth in the past twenty years has been vigorous, and in 1910 it made about 23 per cent. of the world's pig iron and steel. This left the position of the United Kingdom about equal to that of Germany in 1890. But during the same time the growth of the United States was unprecedented. Its output of pig iron in 1910 exceeded, by 6,000 tons, that of the world two decades before, and its steel production was nearly two and one-fourth times larger. All its competitors in the race for the world's supremacy were left hopelessly behind. It produced in 1910 42 per cent. of the world's pig iron and more than 45 per cent. of the steel, and the United States, United Kingdom, and Germany combined yielded four-fifths of the total. It is true that European countries are small compared with America, but their iron is distributed much less widely, and in international relations it is the individual nation

[49] James M. Swank: Manufacture of Iron in All Ages (1892), p. 416.

and not the continent that is considered. Furthermore, since iron is such an important factor in the ecomonic development and possibilities of any nation the comparison is legitimate.

Aside from our rich ores and the Bessemer and open-hearth processes other things have contributed to our position. Chief among these should be mentioned (1) our abundant supply of cheap coke and limestone; (2) machine methods from mine to consumer;

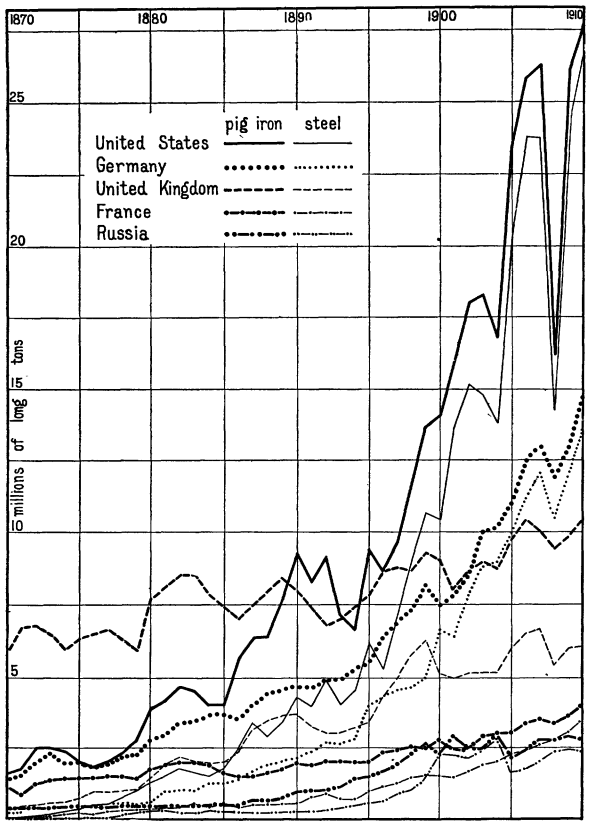

FIG. 14—World's production of pig iron and steel.

(3) large capacity plants under a highly economic system of integration, giving the producer continuous control from the securing of raw materials to the marketing of the finished product; (4) a highly developed home market entirely controlled by home manufacturers, a situation which, other things being equal, tends to make any nation the strongest competitor in foreign markets, espe-

cially during periods of depression at home, and (5) a protective tariff which has aided in making control of the home market possible. The importance of the tariff, however, according to James J. Hill, is slight in comparison with our ores. He holds that "the growth of our enormous iron and steel industries, which are pointed out as the result of our protective tariff, can be more surely traced to our magnificent reserves in the iron mines of Michigan and Minnesota than to any other sources. The cheap production of the highest grade of ore in these mines and the low rate of transportation to Lake Erie ports have done more to build up the iron and steel industries of the United States than any tariffs that have ever been placed upon our statute books. To-day if these mines were closed our superiority in the iron and steel trades of the world would be gone forever."[50]

[50] James J. Hill, cited by Dwight E. Woodbridge, in *Eng. and Min. Journ.*, Vol. 79, p. 61.