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# FUTURE OF LAKE SUPERIOR IRON ORE SUPPLY

George H. Primmer

**F**OR nearly fifty years more than half, and for longer than a quarter century past, in excess of three-fourths of the iron ore mined within United States (Figure 1) moved from Lake Superior district towards consuming areas, in general, lying southeast (Figure 2).

## BEGINNING AND DEVELOPMENT OF ORE SHIPPING

One hundred thirty-two tons of iron ore on the brigantine "Columbia" passed through St. Mary's canal in August, 1855, the first such cargo taken from upper to lower lake ports without breaking bulk. Lake Superior ore shipments mounted slowly till after 1880, and rapidly not till some time after the opening of Mesabi Range. Lake Superior district then began to supply an increasing share of national iron ore consumption; demand rose with population increase and with growth of per capita consumption of iron and steel, a consumption that by 1900 measured seven-fold that of a half century previous, and more than four times that of thirty years earlier.

Average annual shipments for the decade 1921-1930 surpassed fifty million tons, reaching an all-time peak in 1929 when some sixty-three million tons moved from six upper lake to nearly three times as many lower lake ports. Some years after peak shipment the lake ore fleet yet consisted of some three hundred thirty vessels. Their combined carrying capacity, on the nineteen foot draft then current, totalled 2,780,500 tons per round trip. Since lake carriers can make as many as twenty-five round trips per season past records could fall

without further additions to the ore carrying fleet.

Following the first forty years of shipping ore from Lake Superior area, new discoveries seemed imminent enough to provide for all future demands; after a second four decades, with shipment proceeding at a much faster rate than during the first, a student of the iron ore industry finds the district confronted with a

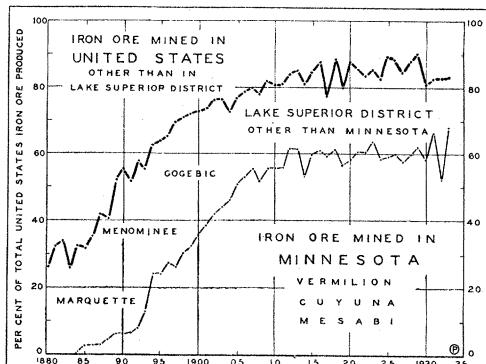


FIGURE 1.—For a generation past Lake Superior district produced an average of eighty per cent of all iron ore mined in United States. Most of Lake Superior ore lay within Minnesota where the Mesabi yields most heavily.

very real problem of adequacy of supply for future shipments. Published estimates of life of iron ore shipping range from cessation of significant movement from Lake Superior some time between 1950 and 1960, and a possible continuation of shipments until some five thousand years later. This article proposes no absolute forecast of the date of the concluding shipment of Lake Superior iron ore. Its purpose consists rather in setting forth briefly some of the considerations which should guide geographic thinking concerning the future of the region as an ore producer.

### RESERVE OF LAKE SUPERIOR REGION

Except for those comparatively few spots where outcrops revealed deposits, explorers seeking iron ore around Lake Superior chose from a number of methods including magnetic surveys, test pitting, and drilling. Drill holes, made in softer material by churn drills and in hard rock by diamond drills (Figure 3), furnished most knowledge of sub-surface deposits. Samples from diamond drilling include drill cores which make

Future shipments of Lake Superior iron ores, manifestly, depend on the regional reserves whose estimated totals constantly fluctuate through removals and through re-definition of what constitutes assured reserve. Recent official estimates for Lake Superior district show less than one and a half billion tons of assured (Figure 4), and a somewhat smaller probable reserve. Length of future shipping period does not derive directly from knowledge of assured reserve and average annual tonnage

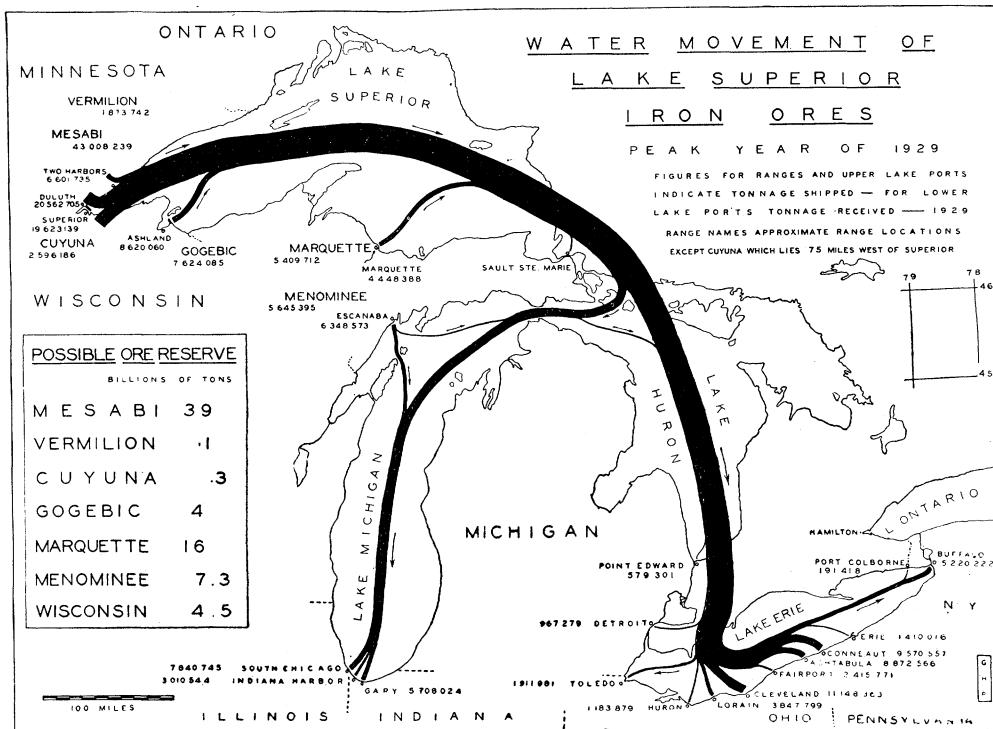


FIGURE 2.—Nearly all Lake Superior iron ore moves southeast by water. Receiving ports on the lower, greatly exceed in number shipping ports on the upper lakes.

possible the more satisfactory measurements and analyses. Even for deep lying deposits fairly accurate estimates of volume of ore of various grades prove possible. Quality and specific gravity indicate a range from less than nine to more than twenty cubic feet per ton of ore or of concentrate.

shipped. To some extent discoveries of earlier unknown ore and, in much greater amount, change from probable to assured reserve of ores amenable to new methods of processing, result in a depletion of assured reserve only about one half as great as shipments of recent years. Conceivably, beneficiation might

develop to the extent of full maintenance of present reserve for an indefinite period.

In 1910 Lake Superior reserves included fifty-seven tons of ore for each ton of annual smelting capacity of blast furnaces using ore from the region. Increase in furnace capacity and in resultant ore demand, along with a small decrease in reserves, by 1920 decreased the ratio of reserve tonnage to smelting capacity to thirty-six; and by 1930 the ratio dropped to thirty-two. Regional estimates, obviously, give no direct knowledge of reserve status of any one company operating within the region. Some companies have so high a reserve as to make its maintenance unduly expensive; others control so small a reserve as to make insecure their plans for continuing operations in a rather immediate future. Companies of low reserve, to continue in business, must perforce soon acquire more in Lake Superior district or elsewhere.

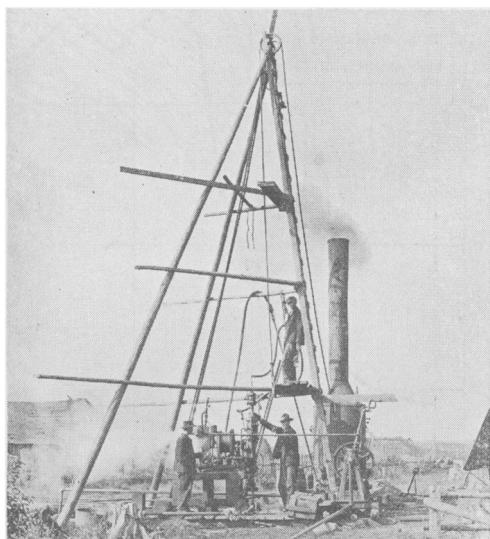


FIGURE 3.—Exploration drill outfit. Such equipment using a diamond drill furnishes hard rock cores for determining quantity and quality of underground ore deposits. Churn drills operate in drift and in less resistant rock. Lake Superior district contains tens of thousands of test holes. (Photo by Gallagher, Duluth.)

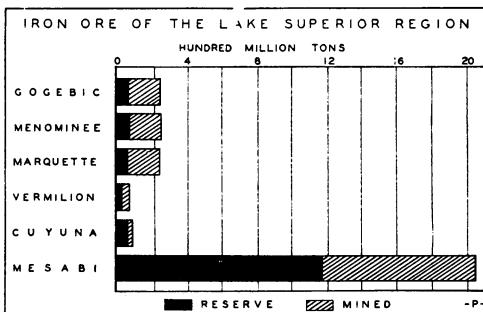


FIGURE 4.—Only assured reserves show on this chart. Probable reserves total almost as much and possible reserves many times the assured.

#### BENEFICIATING OF LAKE SUPERIOR IRON ORES

The district boasts well over a billion tons of probable ore, a reserve but slightly smaller than the assured reserve. Besides, vastly greater amounts of low grade ores, through new types of processing or commercial application of processes now known, may become available. More than forty plants now beneficiate Michigan and Minnesota ores.

Most concentration in Lake Superior district involves improvement of silicious ores by washing. Early this century a Cedartown, Georgia, plant received an experimental carload. Mesabi operators soon after built a small plant. They began the large Coleraine plant (Figure 5) in 1909 and completed the fifth unit in the spring of 1911. Trout Lake provides it with (1) clear water for the power plant, (2) a place to dispose of tailings, and (3) an abundance of wash water through a forty inch four hundred foot steel intake pipe. The five units of this one large plant produced more than two and a half million tons of concentrate in 1912. The district beneficiated nearly seven million tons in 1933, of which Minnesota produced nearly five million tons largely by washing (Fig. 6).

After trying out an experimental mill built at Duluth in 1916, the Mesabi Iron Company erected the first unit of a commercial plant at Babbitt, Minnesota, to

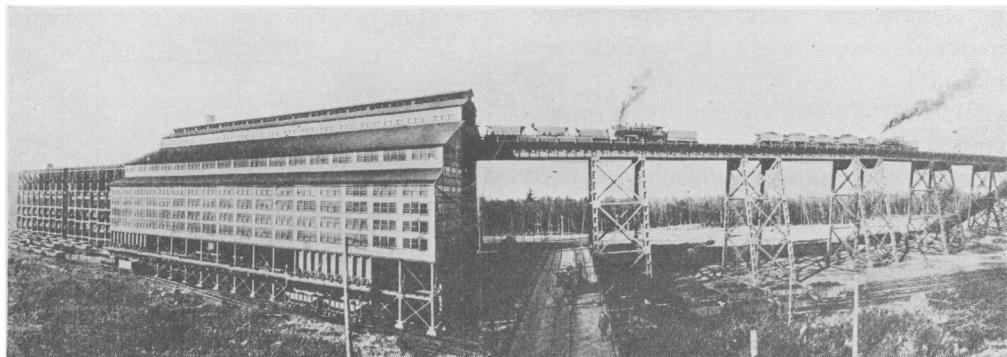


FIGURE 5.—Trout Lake concentrator near Coleraine, Minnesota. Western Mesabi lean sandy ores, through washing, yield a product of satisfactory iron content. (Photo by Gallagher, Duluth.)

process lean magnetic ores of the vicinity, hard ores analyzing about twenty-eight per cent iron. The plant maintained activity from 1922 to 1924, grinding the low grade ore in a ball mill and magnetically removing a concentrate which it sintered into a shipping ore of around sixty-five per cent iron. The product sold for about \$1.50 per ton above the usual prices for the ores showing fifty-two per cent iron, for some years mean content of shipments from the region. The plant, now in its tenth year of idleness, awaits prices that again shall justify its activity.

For the most part lean ores of Lake Superior district comprise non-magnetic types, in which iron oxide and silica lie mixed so intimately that as yet no economical commercial process for beneficiation has been announced. Experimental processing includes (1) fine crushing, (2) separation, and (3) agglomeration into strong porous lumps suitable for blast furnace use. Roasting of ore before separation, for which natural gas might be piped to furnish a satisfactory cheap fuel, makes possible a magnetic concentration. Profits will flow from such beneficiation of ore only when it can be done more economically or when concentrate prices rise. Experimenters expect to have made these ores

available before they become absolutely necessary to bolster up the regional reserve (Figure 7).

#### TAXATION AND IRON ORE EXPLOITATION

State and local taxing units collect a significant portion of their operating

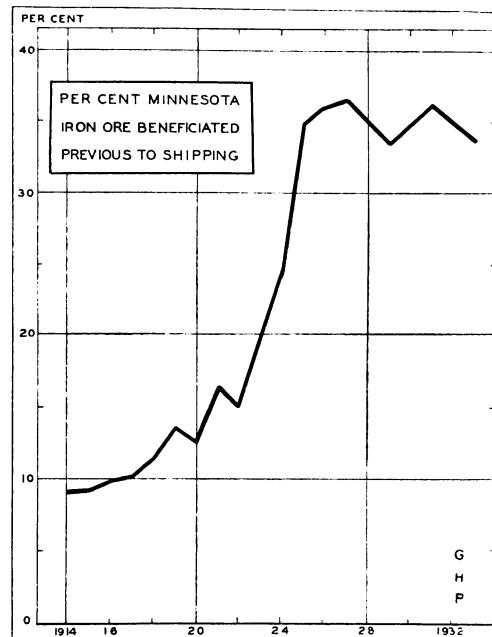


FIGURE 6.—The rapid rise after 1922 marks an increase largely in crushing and screening, changes not increasing iron content of ore. Bureau of mines records, based on a more restricted meaning of beneficiation, show but fifteen to twenty per cent for recent years.

revenue from Lake Superior mining property. The total tax levy per ton of ore shipped from St. Louis County, Minnesota, rose from forty-one cents in 1929 to nearly nineteen times as much in 1932, the higher tax figures indicating a relatively small shipment for 1932. Twenty-six communities of St. Louis

ment of taxes. Utilization of lower grade ores probably would receive stimulus from a lesser tax burden; taxing units already consider advisability of but a nominal tax or entire freedom from taxation of the lowest grade ore now amenable to beneficiation. Encouragement of ore processing on a large scale might

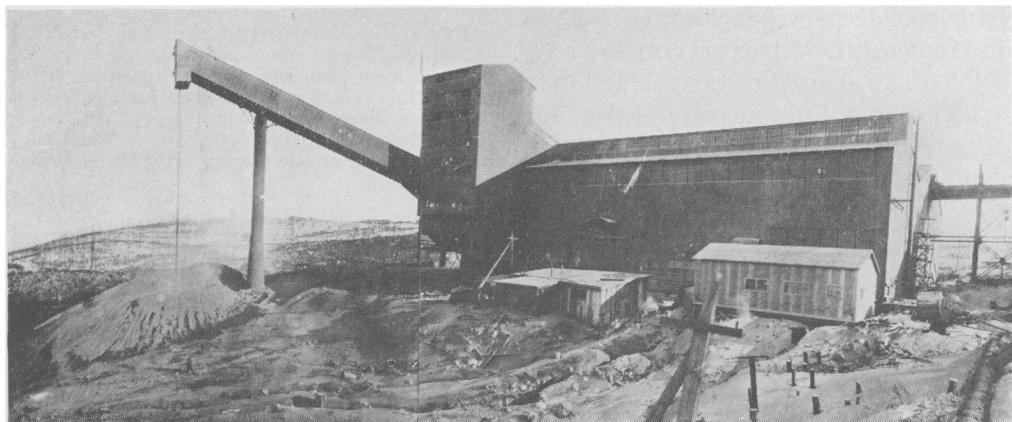


FIGURE 7.—Concentrating plant for eastern Mesabi hard magnetic ore producing a sixty-five per cent sinter from ore of less than half that iron content. (Photo by Gallagher, Duluth.)

County procure an average of some ninety-four per cent of their total tax income from iron ore properties. Stuntz Township, including Hibbing, possesses a valuation one half greater than that of the entire city of Duluth. Though Stuntz contains scarcely one-fifth the population its total tax levy of \$5,531,-196.73 closely approaches the \$5,850,-420.52 of Duluth. Leonidas recently levied 98.9 per cent and Franklin 99.9 per cent of total taxes on mine property.

Mining companies failed to pay much of the tax for 1932 and now seek relief in the courts. Advocates of collection of the full amounts of the taxes levied plus accrued penalties for delinquency maintain that corporation reserves may as well apply to taxes as to dividends.

A 1932 study indicates that in recent years in both Michigan and Minnesota mining companies divert about twenty-five per cent of "true net profit" to pay-

develop taxable wealth in ore bodies at present not thought valuable.

#### PROBABILITY OF NEW ORE DISCOVERIES

For each fourteen tons of ore mined in Michigan in the seventy years immediately preceding 1914 thirteen accessible tons remained. Rate of use with no

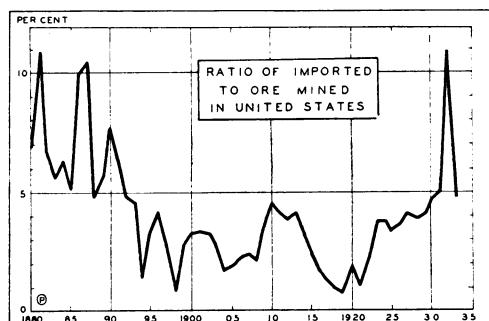


FIGURE 8.—Decline in the ratio of import to domestic iron ore accompanied development of mines in Lake Superior area. The recent rise in the ratio reflects primarily low domestic production.

allowance for additions to reserves indicated exhaustion in seventeen years. More than seventeen years later Michigan lists reserves more than five-sixths as large as in 1914. This seeming anomaly a state report partly explained in advance. It referred to unexplored and partly explored mineral lands, and to probable discoveries attending contemplated deep level exploration. Even in Minnesota new finds yet remain likely, for with an assured reserve of well over a billion tons little incentive exists for current exploration seeking iron ore deposits.

#### POSSIBILITY OF DECLINE IN DEMAND FOR IRON ORE

Aluminum and copper, both produced much more cheaply than formerly, replace iron and steel for numerous uses. Probably substitutes of all kinds tend to lessen demand for new iron ore far less

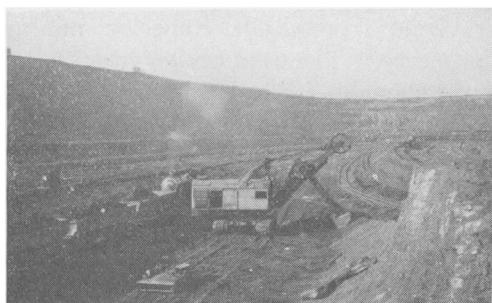


FIGURE 10.—Modern type electrically operated shovel in Mesabi open pit mine. The cable, dragged from the rear as the caterpillar tread moves the outfit forward, carries current from a northeast Minnesota power line net. St. Louis River, descending from peneplain to lake plain, provides much of the power. (Photo by Gallagher, Duluth.)

than use of scrap. Addition of scrap reduced by one-eighth to one-fifth the average amount of iron ore used for each ton of iron and steel products made in United States. Substitution and reuse, patently, tend to prolong producing life of ore areas.

#### COMPETITION OF ORES FROM FOREIGN LANDS

Imported iron ore, though entering United States in increasing quantities in recent decades, shows no alarming percentage increase. From 1892 to 1931 imports for each year amounted to less than five per cent of national production. Recent increase in this ratio (Figure 8), more apparent than real, came only with very low production of domestic ores, a condition presumably but temporary.

#### IMPROVED SHIPPING AND MINING

Continued increases in size of ore carriers on the lakes (Figure 9) exemplify betterments tending toward cheaper ore for eastern furnaces. Since 1914 the larger Soo locks offer a water depth of some twenty-four feet. Probably current deepening of lake harbors to similar depth will initiate a great increase in average load transported by ore carriers. Improved electric haulage in un-

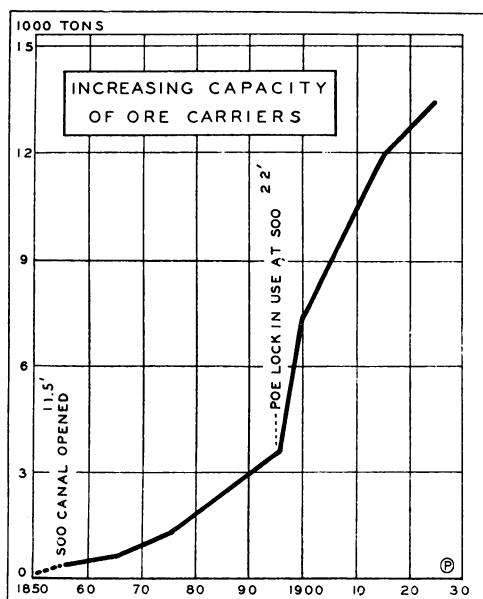


FIGURE 9.—Newly built ore carriers, as a rule, have approximated the maximum size permitted by minimum channels along the route used. The twenty-four and a half feet Soo depth, dating from 1914, will soon be matched by that of the chief lake harbors. This will invite larger carriers and permit loading to much deeper draft many now in use.

derground mines; standard gauge electric locomotives in open pits; electrically operated three hundred ton shovels; and drag-line excavators, stripping forty foot layers, typify equipment being modernized or installed and later reflected in lowered mining costs (Figure 10). Though improvement of machinery tends to increase rate of ore removal, probably only further improvement can continue to keep Lake Superior ranges a major source of iron ore supply.

#### CONFIDENCE OF INDUSTRY IN FUTURE OF LAKE SUPERIOR AREA

Besides improvements and modernization previously mentioned, numerous other investments of fixed capital in Lake

Superior district indicate a confidence in a long future for ore production. Railroads admirably illustrate the point. On one line 99.75 per cent of the cars returned empty to the mine area. Railway executives testified that much of the iron country seemed incapable of agricultural development, enough to support a railway being deemed humanly impossible. Outside mining areas proper the territory using Lake Superior iron ore expresses most confidence. In 1902 it produced less than eleven per cent of United States pig iron. By 1930 it increased its output to nearly twenty-three per cent of that of the nation. Such expansion indicates faith in ability to procure ore for an indefinite period.