

# The Mineral Industry of Minnesota

This chapter has been prepared under a cooperative agreement between the Bureau of Mines, U.S. Department of the Interior, and the Minnesota Geological Survey for collecting information on all minerals except fuels.

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Minnesota continued as the leading iron ore producing State, supplying 60 percent of the total usable ore shipped from mines in the United States. Iron-bearing ores (including manganiferous ores) represented 91 percent of the total value of the State mineral production. Shipments of taconite concentrate decreased slightly, 1 percent from the record output in 1964.

Increases in total value and quantity

were recorded for usable iron ore, manganiferous ore, sand and gravel, and grinding pebbles. Quantity and value decreases were recorded for portland and masonry cements, miscellaneous and fire clays, lime, and peat.

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Table 1.—Mineral production in Minnesota<sup>1</sup>

Mineral	1964		1965	
	Quantity	Value (thousands)	Quantity	Value (thousands)
Clays <sup>2</sup> ..... thousand short tons..	213	\$319	207	\$311
Iron ore (usable) thousand long tons, gross weight.....	49,626	449,289	50,873	459,290
Manganiferous ore (5 to 35 percent Mn)				
short tons, gross weight.....	188,481	W	280,705	W
short tons.....	19,188	405	7,346	123
Sand and gravel..... thousand short tons..	35,817	25,907	37,545	27,296
Stone..... do.....	3,588	12,297	4,371	11,680
Value of items that cannot be disclosed: Abrasive stones, cement, fire clay, gem stones, lime, and values indicated by symbol W.....	XX	9,278	XX	9,060
Total.....	XX	497,495	XX	507,760

W Withheld to avoid disclosing individual company confidential data; included with "Value of items that cannot be disclosed."

XX Not applicable.

<sup>1</sup> Production as measured by mine shipments, sales, or marketable production (including consumption by producers).

<sup>2</sup> Excludes fire clay included with "Value of items that cannot be disclosed."

Table 2.—Value of mineral production in constant 1957-59 dollars  
(Millions)

Year	Value	Year	Value
1956.....	\$548	1961.....	436
1957.....	593	1962.....	416
1958.....	394	1963.....	425
1959.....	341	1964.....	451
1960.....	507	1965.....	459

P Preliminary.    R Revised.

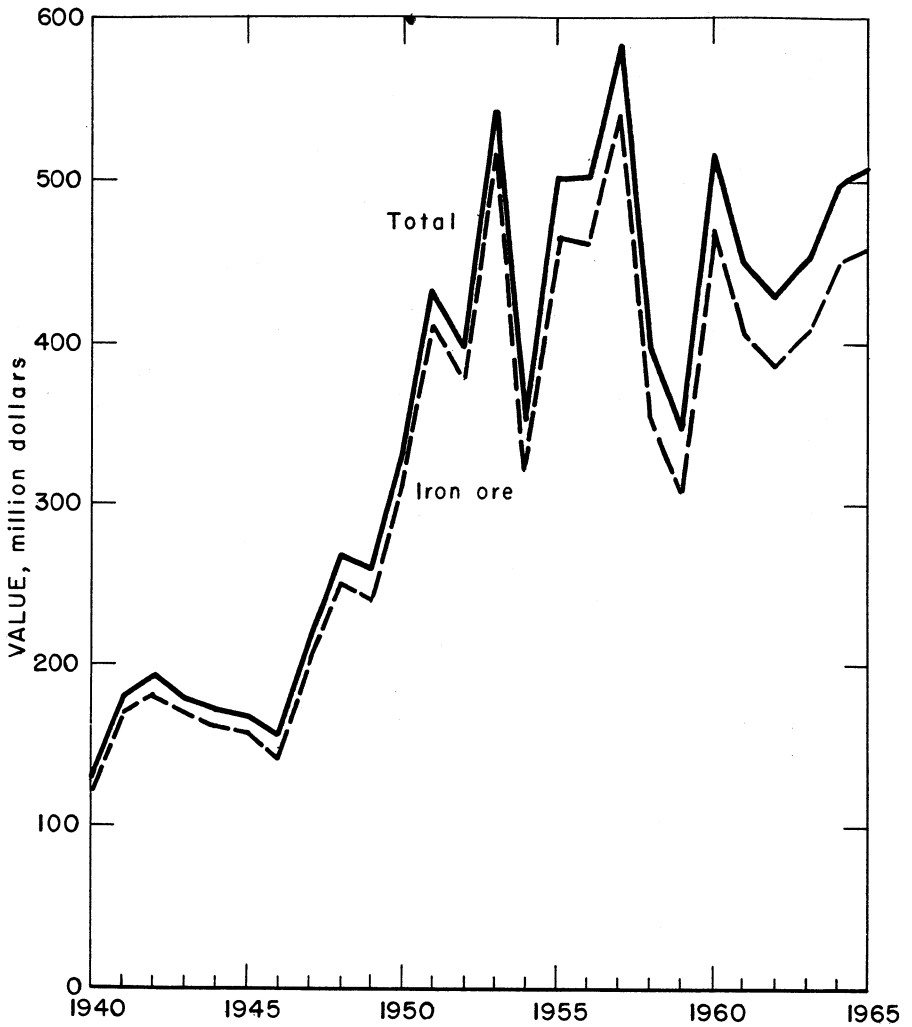


Figure 1.—Value of iron-ore shipments and total value of mineral production in Minnesota.

Table 3.—Employment and injury experience in the mineral industries

Year and industry	Average men working daily	Days active	Man-days worked (thousands)	Man-hours worked (thousands)	Number of injuries		Injury rates per million man-hours	
					Fatal	Non-fatal	Frequency	Severity
1964:								
Peat.....	88	68	6	47	-----	-----	-----	-----
Metal.....	9,219	270	2,493	19,869	3	45	2.42	1,183
Nonmetal.....	249	245	62	493	1	28	58.80	13,093
Sand and gravel.....	2,213	164	364	3,098	2	53	17.76	5,081
Stone.....	1,701	256	436	3,657	-----	89	24.34	548
Total.....	13,470	249	3,361	27,164	6	215	8.14	1,755
1965: <sup>P</sup>								
Peat.....	38	53	2	16	-----	-----	-----	-----
Metal.....	9,505	288	2,741	21,944	-----	80	3.65	237
Nonmetal.....	225	271	61	486	1	33	69.96	13,840
Sand and gravel.....	2,180	164	358	3,054	-----	52	17.03	494
Stone.....	1,590	241	383	3,209	-----	60	18.70	414
Total.....	13,538	262	3,545	28,709	1	225	7.87	514

<sup>P</sup> Preliminary.

## REVIEW BY MINERAL COMMODITIES

### METALS

**Iron Ore.**—Minnesota mines shipped 50.9 million long tons of usable iron ore (excluding ore containing 5 percent or more manganese), 2 percent more than in 1964. Total mine value of shipments increased to \$459.3 million. Nearly 77 percent of the total usable ore shipped in 1965 was beneficiated. Shipments of taconite concentrates were 18.9 million tons and comprised 37 percent of the State iron ore shipments. Average natural iron content of usable ore was 56.7 percent, compared with 56.4 percent in 1964. Fourteen mining companies produced iron ore from five counties. Mesabi Range mines in St. Louis and Itasca Counties produced 97 percent of the total. The Vermilion Range in St. Louis County, the Cuyuna Range in Crow Wing County, and the Spring Valley district in Fillmore and Olmsted Counties produced the remainder.

Minnesota observed the tenth anniversary of the start of its full-scale commercial taconite industry. Reserve Mining Co.'s Silver Bay plant had an initial rated capacity of 3.75 million tons when it began processing in October 1955. This plant, the world's largest, will have a rated capacity of 10.7 million tons of pellets per year on completion of its current expansion program in 1966. Since passage of the taconite amendment in 1964, Minnesota has had extensive activity in taconite

plant construction with an estimated \$400 million committed for new taconite plants and expansion programs. Eveleth Taconite Co.'s 1.6-million-ton-per-year pellet plant at Forbes was completed in November, and production of pellets began in December. Three new plants were in various stages of construction. In the Nashauk-Keewatin area, The Hanna Mining Co. was building two plants with a total rated capacity of 4.4 million tons of pellets per year. United States Steel Corp. was constructing a 4.5-million-ton-per-year pellet plant at Mountain Iron. Jones & Laughlin Steel Corp.'s proposed 2-million-ton-per-year pellet plant near Biwabik was in design stage. A \$50 million expansion program at Erie Mining Co.'s taconite plant at Hoyt Lakes was in progress. Annual capacity will be increased 2.8 million tons to 10.3 million tons of pellets. Development of the Dunka River mine, which will supplement Erie's crude ore supply, was completed. Including presently operating plants and those in construction and design stages, Minnesota will have in the near future an annual pellet capacity of 33.5 million tons, representing an investment of over \$1 billion.

Pacific Isle Mining Co. reopened the Higgins No. 2 mine, and Pittsburgh Pacific Co. opened a new mine, the Arne, at Aurora. Both mines are natural ore operations. At the end of the shipping sea-

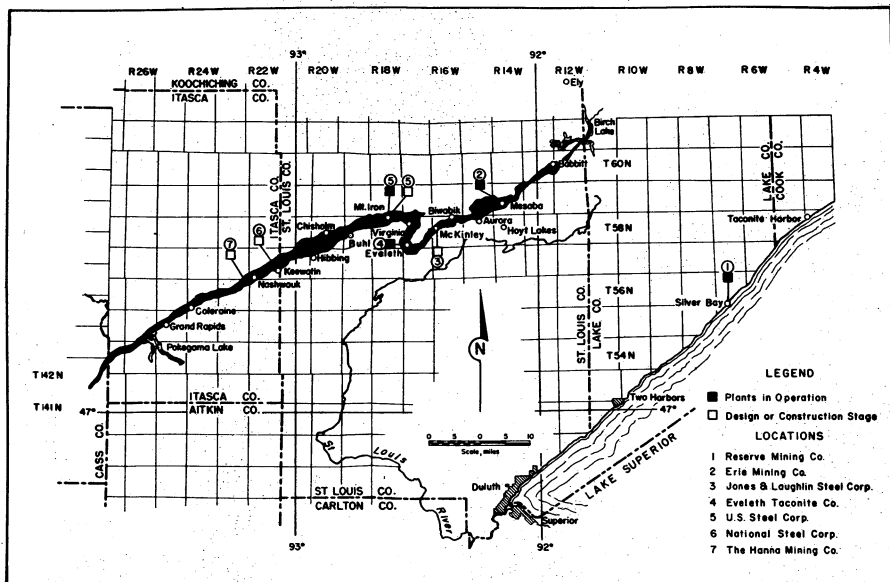


Figure 2.—Locations of currently operating and proposed Mesabi Range taconite-processing plants.

son, The Hanna Mining Co. discontinued mining at the Morton and Mississippi Group open-pit mines on the Mesabi Range. The Duluth, Missabe, and Iron Range Railway constructed a bulk material handling and storage facility at Duluth. The Reserve Mining Co. constructed a \$5 million research laboratory at Silver Bay, primarily for research on plant processes and to improve the quality of Reserve pellets. The Hanna Mining Co. and Midland-Ross Corp. conducted research on a prerduced pellet process at Hanna's Cooley pilot plant. The Midland-Ross Corp. process for upgrading the iron content of pellets to as much as 90 percent iron was proposed for installation at the National Steel Pellet Co. taconite plant under construction near Keewatin.

W. S. Moore Co. and Northern Natural Gas Co. continued research on reduction roast techniques for low-grade nonmagnetic ores.

Lake Erie base prices for iron ore were unchanged from 1964. Average weighted mine value for Minnesota iron ore was \$9.03 compared with \$9.05 in 1964. The decrease was attributed chiefly to slightly

lower taconite concentrate shipments in 1965.

The first iron ore cargo of the 1965 season was loaded at Duluth on April 19. The final cargo of the season left Silver Bay on December 14.

The Federal Bureau of Mines continued research on the beneficiation of nonmagnetic taconites and semi-taconites at its Twin Cities Research Center. Utilization of scrap iron from junked autos as a reductant to convert nonmagnetic iron oxides to magnetic form was investigated and found technically feasible. A pilot plant to be constructed in the western Mesabi Range area to demonstrate the feasibility of scrap iron reduction process and Bureau-developed flotation processes was in design stage.

A report on Bureau of Mines research on nonmagnetic taconites of the central Mesabi Range was published.<sup>3</sup>

The University of Minnesota Mines Experiment Station continued high intensity,

<sup>3</sup> Heising, L. F., and D. W. Frommer. Lake Superior Iron Resources. Preliminary Sampling and Metallurgical Evaluation of Central Mesabi Nonmagnetic Taconites. BuMines Rep. of Inv. 6650, 1965, 28 pp.

**Table 4.—Crude iron ore<sup>1</sup> data, in 1965, by counties and ranges**  
(Thousand long tons)

County and range	Stocks Jan. 1	Production		Shipments		Stocks Dec. 31
		Under- ground	Open pit	Direct to consumers	To con- centrators	
<b>County:</b>						
Crow Wing.....	65	337	30	359	-----	73
Fillmore <sup>2</sup> .....	-----	-----	1,088	-----	1,088	-----
Itasca.....	-----	-----	29,590	97	29,493	-----
St. Louis.....	696	926	81,957	11,123	71,474	983
<b>Total<sup>3</sup>.....</b>	<b>761</b>	<b>1,263</b>	<b>112,664</b>	<b>11,579</b>	<b>102,054</b>	<b>1,056</b>
<b>Range:</b>						
Cuyuna.....	65	337	30	359	-----	73
Mesabi.....	696	-----	111,547	11,220	100,041	983
Vermilion.....	-----	926	-----	-----	926	-----
Spring Valley district.....	-----	-----	1,088	-----	1,088	-----
<b>Total<sup>3</sup>.....</b>	<b>761</b>	<b>1,263</b>	<b>112,664</b>	<b>11,579</b>	<b>102,054</b>	<b>1,056</b>

<sup>1</sup> Exclusive of ore containing 5 percent or more manganese.<sup>2</sup> Includes ore from one property in Olmsted County.<sup>3</sup> Data may not add to totals shown because of rounding.**Table 5.—Usable iron ore<sup>1</sup> data, in 1965, by counties and ranges**  
(Thousand long tons)

County and range	Stocks Jan. 1	Production	Iron content of production	Shipments	Stocks Dec. 31
<b>County:</b>					
Crow Wing.....	65	367	180	359	73
Fillmore <sup>2</sup> .....	38	625	294	565	98
Itasca.....	1,374	10,401	5,847	9,053	2,722
St. Louis.....	2,855	40,660	23,189	40,896	2,619
<b>Total.....</b>	<b>4,332</b>	<b>52,053</b>	<b>29,510</b>	<b>50,873</b>	<b>5,512</b>
<b>Range:</b>					
Cuyuna.....	65	367	180	359	73
Mesabi.....	4,112	50,279	28,575	49,146	5,245
Vermilion.....	117	782	460	803	96
Spring Valley district.....	38	625	294	565	98
<b>Total.....</b>	<b>4,332</b>	<b>52,053</b>	<b><sup>3</sup> 29,510</b>	<b>50,873</b>	<b>5,512</b>

<sup>1</sup> Exclusive of ore containing 5 percent or more manganese.<sup>2</sup> Includes ore from one property in Olmsted County.<sup>3</sup> Data do not add to total shown because of rounding.

flotation and pilot plant scale research on beneficiation of low-grade Mesabi iron ores under technical assistance grants provided by the Federal Area Redevelopment Administration and the Minnesota Iron Range and Rehabilitation Commission.

The Minnesota legislature passed a bill providing for a production tax in lieu of a real estate tax on plants constructed to agglomerate natural iron ores. A tax of 5 cents per ton of agglomerate produced, plus one-tenth of 1 cent for each 1 percent that the iron content exceeds 55 percent, will replace the real estate tax on the plant facilities. No firm plans to uti-

ize the benefits of this law were announced, but an agglomerating plant for natural ores was being considered by the Snyder Mining Co. in the Buhl area.

**Manganiferous Ore.**—Manganiferous ore shipments (containing 5 to 35 percent manganese, natural) were 49 percent higher than in 1964. Total shipments were 250,630 long tons consisting of 47,782 tons of direct shipping grade and 202,848 tons of concentrates. Ferruginous manganese ore (containing 10 to 35 percent manganese, natural) represented 87 percent of the shipments. Average natural iron and manganese contents of shipments were

**Table 6.—Usable iron ore <sup>1</sup> produced (direct-shipping and all forms of concentrate), by ranges**  
(Thousand long tons)

Year	Cuyuna	Mesabi	Vermilion	Spring Valley district	Total <sup>2</sup>
1884-1955.....	56,600	2,036,154	92,281	2,793	2,187,827
1956.....	2,242	59,346	1,285	350	63,222
1957.....	2,018	64,537	1,349	382	68,286
1958.....	1,119	39,833	1,027	241	42,221
1959.....	745	33,747	809	576	35,877
1960.....	1,166	54,442	1,361	473	57,442
1961.....	1,095	41,199	930	491	43,714
1962.....	655	43,041	1,158	362	45,216
1963.....	515	43,570	774	524	45,383
1964.....	513	47,256	865	420	49,054
1965.....	367	50,279	782	625	52,053
Total <sup>2</sup> .....	67,035	2,513,403	102,621	7,237	2,690,295

<sup>1</sup> Exclusive after 1905 of iron ore containing 5 percent or more manganese.

<sup>2</sup> Data may not add to totals shown because of rounding.

**Table 7.—Production of usable iron ore in Minnesota**  
(Thousand long tons)

Year	Gross weight		Iron content (percent)	Year	Gross weight		Iron content (percent)
	Ore	Iron content			Ore	Iron content	
1946.....	49,291	25,375	51.48	1956.....	63,222	32,554	51.49
1947.....	62,493	31,865	50.99	1957.....	68,286	35,842	52.49
1948.....	68,036	33,923	49.86	1958.....	42,221	22,793	53.99
1949.....	55,862	28,070	50.25	1959.....	35,877	19,412	54.11
1950.....	65,235	32,206	49.37	1960.....	57,442	31,147	54.22
1951.....	78,486	39,659	50.53	1961.....	43,715	24,215	55.39
1952.....	63,790	31,997	50.16	1962.....	45,216	25,242	55.83
1953.....	80,086	40,291	50.31	1963.....	45,383	25,576	56.36
1954.....	48,752	24,835	50.94	1964.....	49,054	27,660	56.39
1955.....	69,356	35,130	50.65	1965.....	52,053	29,510	56.69

**Table 8.—Iron ore <sup>1</sup> shipped from Minnesota mines**  
(Thousand long tons)

Year	Direct-shipping ore <sup>2</sup>	Concentrates			Total usable ore	Proportion of concentrates to total usable ore (percent)
		Agglomerates	Other	Total		
1956-60 (average).....	25,922	8,173	18,631	26,804	52,726	50.84
1961.....	12,635	14,366	17,698	32,064	44,699	71.73
1962.....	11,466	14,085	18,744	32,820	44,295	74.11
1963.....	7,468	16,857	21,110	37,967	45,435	83.56
1964.....	10,441	19,267	19,917	39,184	49,626	78.96
1965.....	11,579	19,039	20,255	39,294	50,873	77.24

<sup>1</sup> Exclusive of ore containing 5 percent or more manganese.

<sup>2</sup> Includes crushed, screened, and sized ore not further treated.

35.28 and 12.03 percent, respectively.

Chief reason for the increased shipments was the resumption of ore shipments by the Algoma mine. The Algoma mine, opened originally as an underground mine in 1915, was last operated in 1920. The

mine was reopened in 1965 as an open pit operation by The Hanna Mining Co. with ore treated at the Maroco Plant.

Stockpile shipments were made from the Robert, Hopkins, Mangan No. 1, and Sultana mines. Two mines produced manga-

**Table 9.—Dates of first and final cargoes of iron ore at U.S. upper Great Lakes ports**

Port and dock	1964		1965	
	First	Final	First	Final
Ashland, Wis.:				
C&NW.....	May 26	Oct. 23	May 3	<sup>1</sup> Oct. 30
Soo Line.....	May 26	Oct. 23	May 3	<sup>1</sup> Oct. 30
Duluth, Minn.: DM&TR.....	Apr. 4	Nov. 24	Apr. 19	Nov. 20
Escanaba, Mich.: C&NW.....	Apr. 3	Dec. 18	Apr. 7	Dec. 19
Marquette, Mich.:				
Soo Line.....	Apr. 29	Dec. 3	Apr. 26	Dec. 5
LS&I.....	Apr. 12	Dec. 13	Apr. 17	Dec. 12
Silver Bay, Minn.: Reserve.....	Apr. 9	Dec. 11	Apr. 23	Dec. 14
Superior, Wis.:				
GN.....	Apr. 5	Dec. 11	Apr. 24	Dec. 9
NP—Soo Line.....	Apr. 16	Oct. 27	Apr. 29	Oct. 25
Taconite Harbor, Minn.: Erie.....	Apr. 2	Dec. 9	Apr. 21	Dec. 9

<sup>1</sup> Dock closed August 16 but reopened for October shipment making October 30 shipment figure final for 1965 season. Ashland ore dock is not expected to resume iron-ore shipments in 1966.

Source: Skillings' Mining Review.

**Table 10.—Shipments of usable <sup>1</sup> manganiferous iron ore and ferruginous manganese ore from mines in the Cuyuna Range**

Year	Manganiferous iron ore (5 to 10 percent Mn, natural)			Ferruginous manganese ore (10 to 35 percent Mn, natural)			Total shipments (long tons)
	Shipments (long tons)	Contents (natural)		Shipments (long tons)	Contents (natural)		
		Fe (percent)	Mn (percent)		Fe (percent)	Mn (percent)	
1956-60 (average) ..	365,146	39.31	6.54	93,238	33.85	12.13	458,384
1961.....	80,603	32.05	9.01	81,750	35.58	12.29	162,353
1962.....	129,979	40.40	6.19	131,431	33.28	12.60	261,410
1963.....	-----	-----	-----	310,121	33.39	12.18	310,121
1964.....	27,725	36.59	9.68	140,562	32.61	12.38	168,287
1965.....	32,935	33.99	7.27	217,695	35.47	12.75	250,630

<sup>1</sup> Direct-shipping and beneficiated ore.

niferous ore. The Pittsburgh Pacific Co. produced ore from the Sagamore mine.

The Cuyuna Range Mineral Research, Inc., continued research on beneficiation of Cuyuna Range low-grade ores under technical assistance grants from the Federal Area Redevelopment Administration (ARA) and the Iron Range Resource and Rehabilitation Commission (IRRRRC). The University of Minnesota Mines Experiment Station continued research sponsored by the ARA and IRRRC to demonstrate the feasibility of producing a high-grade manganese product from Cuyuna Range tailing rejects resulting from the R-N direct reduction process.

The Federal Bureau of Mines continued research at its Twin Cities Research Center developing methods of utilizing Cuyuna Range low-grade manganese ores.

## NONMETALS

**Abrasive Stone.**—The Jasper Stone Co. produced grinding pebbles and tube-mill liners from a quartzite deposit in Rock County. Sales of grinding pebbles increased substantially in both quantity and value. Output of tube-mill liners decreased in quantity but increased in total value.

**Cement.**—Shipments of portland and masonry cements decreased in both quantity and value from those of 1964. Universal Atlas Cement Division of United States Steel Corp. operated three kilns at the only cement plant in the State, at Duluth. Portland cement output consisted of types I and II (general use and moderate heat) and portland-slag cement. Raw materials used in the manufacturing process included limestone, sand, gypsum, slag,

iron ore, air-entraining aids, and grinding aids. Shipments of portland and masonry cements were primarily to Minnesota, with lesser shipments to Michigan, Montana, North Dakota, Ohio, South Dakota, and Wisconsin.

Marquette Cement Manufacturing Co. completed construction of a distributing plant in Bloomington. This plant was one of several constructed in recent years to facilitate rapid truck delivery of bulk cement in the Minneapolis-St. Paul metropolitan area. Shipments to distribution centers in this area were generally by rail from producing plants.

**Clays.**—Total production of miscellaneous clay and shale decreased 3 percent in quantity from 1964. Chief reason for the decline was a decrease in output for vitrified sewer pipe and building brick. Output for lightweight aggregate increased slightly over that of 1964.

Production was reported from Brown, Goodhue, Hennepin, Ramsey, and Redwood Counties. No production was reported from Carlton County in 1965. In previous years a minor amount of clay was produced for floor and wall tile.

Clay and shale were used for manufacture of lightweight aggregate, building brick, vitrified sewer pipe, and other products. Red Wing Potteries, Inc., produced dinnerware and art pottery at Red Wing, chiefly from raw materials produced in other States.

The Minnesota Geological Survey continued its investigation of kaolin and other clay resources of the Minnesota River Valley in Brown, Redwood, and Renville Counties.

**Gem Stones.**—Minor quantities of semi-precious gem stones, principally agates, were collected by hobbyists. Gem materials were found chiefly along the north shore of Lake Superior, along the Mississippi River, and in gravel pits in the southeastern part of the State. The material was used for handmade jewelry and personal collections.

**Lime.**—Cutler-Magner Co., the only commercial producer of lime, operated a kiln at Duluth, using Michigan limestone. Most of the lime produced was used in Minnesota with lesser amounts shipped to Iowa, Michigan, North Dakota, South Dakota, and Wisconsin. The American Crystal Sugar Co. produced lime at Chaska,

Carver County; at Moorhead, Clay County; and at Crookston and East Grand Forks, Polk County. The lime produced was used for sugar refining. About 93 percent of the State total lime production was used for chemical and other industrial uses, 6 percent for construction, and the remainder for agricultural purposes.

**Perlite.**—Minnesota Perlite Corp. and Western Mineral Products Co. produced expanded perlite from crude material mined in Nevada and New Mexico. The expanded perlite was used for lightweight concrete aggregate, building plaster, filler, soil conditioning, and other miscellaneous uses. Total sales were about equal to those of 1964.

**Sand and Gravel.**—A record high was established for sand and gravel output. The new mark of 37.5 million tons represented a 5-percent increase over the previous high set in 1964. Chief reason for the gain was the 1.6-million-ton increase in demand for building construction. Significant decreases in quantity were reported for paving and railroad ballast. Industrial sand production increased 4 percent. About 80 percent of the total was used for paving and fill, 17 percent for building, and the remainder for other uses.

Sand and gravel production was reported from all 87 counties in the State. Seventy-one percent of the total output was produced by 296 commercial operations, and 267 Government-and-contractor operations supplied the remainder. Nearly 91 percent was transported by truck, 4 percent by rail, and 5 percent by river barge. Major producing counties in order of production were Hennepin, St. Louis, Washington, Dakota, Otter Tail, Le Sueur, Clay, Kanabec, Polk, and Ramsey. The above 10 counties produced about 51 percent of the State total.

**Stone.**—Combined output of stone increased about 22 percent in quantity but value decreased 5 percent. The decrease in value was attributed mainly to decreased sales of dimension granite and limestone for architectural purposes.

Limestone was produced in 15 counties in the southcentral and southeastern parts of the State. The five major limestone producing counties by value—Blue Earth, Scott, Winona, Washington, and Le Sueur—produced 62 percent of the total. Dimension limestone decreased 20 percent in



**Table 11.—Sand and gravel sold or used by producers, by classes of operations and uses**  
(Thousand short tons and thousand dollars)

Class of operation and use	1964		1965	
	Quantity	Value	Quantity	Value
<b>Commercial operations:</b>				
Sand:				
Building.....	3,488	\$2,697	4,454	\$3,461
Paving.....	2,165	1,318	1,670	1,111
Fill.....	564	247	855	317
Railroad ballast.....	24	15	5	5
Other <sup>1</sup> .....	295	991	380	1,027
Total.....	6,536	5,268	7,364	5,921
Gravel:				
Building.....	2,682	3,763	3,319	4,896
Paving.....	12,161	8,285	13,786	8,962
Railroad ballast.....	431	251	357	165
Fill.....	942	513	1,951	951
Other.....	185	140	39	24
Total.....	16,401	12,952	19,452	14,998
Total sand and gravel.....	22,937	18,220	26,816	20,919
<b>Government-and-contractor operations:</b>				
Sand:				
Building.....			7	4
Paving.....	2,535	1,381	2,036	1,083
Fill.....	158	54	123	42
Other.....	14	5	36	12
Total.....	2,707	1,440	2,202	1,141
Gravel:				
Building.....			7	4
Paving.....	9,902	6,154	8,202	5,165
Fill.....	258	88	298	60
Other.....	13	5	20	7
Total.....	10,173	6,247	8,527	5,236
Total sand and gravel.....	12,880	7,687	10,729	6,377
<b>All operations:</b>				
Sand.....	9,243	6,708	9,566	7,062
Gravel.....	26,574	19,199	27,979	20,234
Grand total.....	35,817	25,907	37,545	27,296

<sup>1</sup> Includes grinding and polishing sand (1964), blast, engine, filler, foundry, glass, molding, oil (hydrafrac), pottery, porcelain, tile, and other construction and industrial sands.

both quantity and value, but increased output of crushed and broken limestone resulted in a slight increase in total value compared with 1964 figures. About 91 percent of the commercial crushed limestone was shipped by truck, 8 percent by water, and the remainder by rail.

Granite production increased about 18 percent in quantity but decreased 15 percent in value from that of 1964. Chief reason for the value decrease was attributed to lesser sales of dressed architectural stone. Quantity and value of crushed and broken granite increased 21 and 27 percent, respectively, compared with 1964 figures. Production was reported from Big Stone, Kanabec, Lac qui Parle, Mille Lacs,

Redwood, Renville, Stearns, and Yellow Medicine Counties. Finishing plants were operated at Delano, Cold Spring, and St. Cloud.

Crushed and broken basalt for concrete aggregate and roadstone was produced in St. Louis County by the Zenith Dredge Co. All material was shipped by truck.

Quartzite production from Nicollet and Rock Counties increased 34 and 44 percent in quantity and value, respectively. Quantity increases were recorded for concrete aggregate and roadstone, poultry grit, filter, and refractory purposes whereas a decrease was reported for riprap use. About 59 percent of the total output was

Table 12.—Granite sold or used by producers, by uses

Use	1964		1965	
	Quantity	Value (thousands)	Quantity	Value (thousands)
<b>Dimension:</b>				
Rough monumental.....thousand cubic feet..	7	\$25	W	W
Dressed monumental.....do.....	93	950	84	\$1,217
Other <sup>1</sup> .....do.....	352	4,157	226	2,837
Total.....approximate thousand short tons <sup>2</sup> ..	38	<sup>3</sup> 5,133	26	4,054
<b>Crushed and broken:</b>				
Concrete aggregate and roadstone.....thousand short tons..	80	158	W	W
Stone sand.....do.....	69	9	W	W
Other <sup>4</sup> .....do.....	360	504	617	857
Total.....do.....	<sup>3</sup> 510	671	617	857
Grand total.....do.....	<sup>3</sup> 547	5,804	643	4,911

W Withheld to avoid disclosing individual company confidential data; included with "Other."

<sup>1</sup> Includes granite for rough (1964) and dressed architectural and rough monumental (1965) use.

<sup>2</sup> Average weight of 166 pounds per cubic foot used to convert cubic feet to short tons.

<sup>3</sup> Data do not add to total shown because of rounding.

<sup>4</sup> Includes granite for riprap, railroad ballast, fill, poultry grit, and items indicated by symbol W.

Table 13.—Limestone sold or used by producers, by uses

Use	1964		1965	
	Quantity	Value (thousands)	Quantity	Value (thousands)
<b>Dimension:</b>				
Rough construction and rubble.....thousand short tons..	6	\$44	W	W
Rough architectural.....thousand cubic feet..	W	W	W	W
Sawed.....do.....	40	259	21	\$96
House stone veneer.....do.....	W	W	95	254
Cut.....do.....	158	1,731	134	1,416
Flagging.....do.....	W	W	W	W
Total.....approximate thousand short tons <sup>1</sup> ..	30	2,323	24	1,847
<b>Crushed and broken:</b>				
Riprap.....thousand short tons..	19	28	159	100
Concrete aggregate and roadstone.....do.....	2,371	2,792	3,043	3,713
Agriculture.....do.....	412	645	293	466
Railroad ballast.....do.....	---	---	7	10
Other <sup>2</sup> .....do.....	66	399	57	343
Total.....do.....	<sup>3</sup> 2,869	<sup>3</sup> 3,865	<sup>3</sup> 3,560	<sup>3</sup> 4,631
Grand total.....do.....	2,899	6,188	<sup>3</sup> 3,583	6,478

W Withheld to avoid disclosing individual company confidential data; included with "Total."

<sup>1</sup> Average weight of 160 pounds per cubic foot used to convert cubic feet to short tons.

<sup>2</sup> Includes limestone for asphalt, fertilizer, flux, poultry grit, and other uses.

<sup>3</sup> Data do not add to total shown because of rounding.

shipped by truck, with the remainder by rail.

Production of marl for agricultural use decreased 11 percent in quantity and 21 percent in value, respectively, from 1964. Marl was produced in Wadena and Cass Counties.

**Sulfur.**—Elemental sulfur was recovered

by the Great Northern Oil Co. as a by-product at its Pine Bend refinery in Dakota County. Shipments decreased in quantity but increased in total value compared with those of 1964.

**Vermiculite.**—Crude vermiculite mined in Montana was exfoliated by three companies in Ramsey and Hennepin Counties.

The exfoliated material was used for building insulation, plaster and concrete aggregate, litter, fireproofing, acoustical and other miscellaneous uses. Output was slightly less than in 1964.

#### MINERAL FUELS

**Peat.**—Production was reported by seven companies from operations in Aitkin, Carlton, Itasca, Otter Tail, Pine, and St. Louis Counties. Sales of peat decreased 62 percent in quantity and 70 percent in value

from 1964 figures. Production problems due to excessively wet bogs were cited as the chief reason for the lower quantity produced. Moss peat was the predominate type produced, 88 percent of the total; reed-sedge represented 11 percent, and humus the remainder.

Peat was sold for soil improvement and other horticultural uses. It was sold in bulk and in containers ranging in size from 1 quart to 6 cubic feet.

### REVIEW BY COUNTIES

Mineral output was reported from every county in the State. St. Louis and Itasca Counties, with their large-scale iron mining industry, contributed 77 and 14 percent, respectively, of the State total value. Sand and gravel was produced in each of the State's 87 counties. Stone was produced in 29 counties.

Mineral value increased in 41 counties and decreased in 46 counties. Virtually all gains, except for iron-ore producing counties, were the result of increased requirements for road construction.

**Aitkin.**—Kimball & Sons Co. and Colby Pioneer Peat Co. produced peat near Hill City and Wawina, respectively, for soil improvement and other horticultural uses. Production decreased considerably from that of 1964 because of excessively wet conditions in the bogs.

Three companies operated portable plants near Cromwell and Hill City and produced gravel for road use and fill. The State and county highway departments produced and/or contracted for paving sand and gravel.

**Big Stone.** Delano Granite Works, Inc., and Cold Spring Granite Co. quarried granite at Odessa and Ortonville, respectively. The rough stone was finished at plants in Delano and Cold Spring. Sand and gravel for building and road construction was produced by Duininc Bros. & Gilchrist Co. and Hallett Construction Co. The county highway department produced and contracted for paving gravel.

**Blue Earth.**—Mankato Ag Lime & Rock Co. and Lundin Construction Co. produced crushed and broken limestone near Mankato for road construction, agricultural use, and riprap. Vetter Stone Co. and Mankato Stone Co. produced dimension limestone at Mankato primarily for architect-

tural use. Sand and gravel for building, road construction, and other uses was produced by Guaranteed Gravel & Sand Co., Hiniker Sand & Gravel Co., and North Star Concrete Co. with fixed plants at Mankato. The county highway department contracted for paving gravel.

**Brown.**—Ochs Brick & Tile Co. produced shale for building brick and lightweight aggregate from a pit near Springfield. About 367,000 tons of sand and gravel was produced. Roberts Bros. and Wallner Construction Co., Inc., operated fixed sand and gravel plants at Sleepy Eye and New Ulm, respectively, and produced material for building and road construction. The county highway department contracted for paving gravel. The State highway department produced and contracted for paving sand and gravel.

**Carlton.**—Red Wing Peat Co. produced peat for soil improvement from a bog near Cromwell. About 459,000 tons of sand and gravel was produced by five companies and three governmental units from pits near Carlton, Cloquet, and Moose Lake. The material was used for road construction, building, and railroad ballast. Nemadji Tile & Pottery Co., which produced clay at Moose Lake for floor tile in 1964, was idle.

**Carver.**—American Crystal Sugar Co. produced quicklime at Chaska and used the entire output for sugar refining. Wm. Mueller & Sons and Rosenwinkel Sand & Gravel Co., Inc., produced sand and gravel at fixed plants near Hamburg and Chaska, respectively. Output was for building, road construction, and fill.

**Clay.**—Quicklime was produced by American Crystal Sugar Co. for use in sugar refining at Moorhead. About 1 million tons of sand and gravel was produced

Table 14.—Value of mineral production in Minnesota, by counties

County	1964	1965	Minerals produced in 1965 in order of value
Aitkin	\$356,000	\$170,800	Sand and gravel, peat.
Anoka	W	W	Sand and gravel.
Becker	W	468,000	Do.
Beltrami	134,000	157,000	Do.
Benton	109,000	64,000	Do.
Big Stone	402,353	W	Stone, sand and gravel.
Blue Earth	1,776,355	1,528,448	Do.
Brown	351,519	319,593	Sand and gravel, clays.
Carlton	469,648	292,000	Sand and gravel, peat.
Carver	364,932	419,926	Sand and gravel, lime.
Cass	122,160	169,331	Sand and gravel, stone.
Chippewa	204,000	191,000	Sand and gravel.
Chisago	157,000	115,000	Do.
Clay	1,341,605	1,540,827	Sand and gravel, lime.
Clearwater	14,000	129,000	Sand and gravel.
Cook	62,000	270,000	Do.
Cottonwood	126,000	117,000	Do.
Crow Wing	4,657,656	4,460,550	Iron ore, manganese ore, sand and gravel.
Dakota	1,338,791	2,145,585	Sand and gravel, stone.
Dodge	W	W	Stone, sand and gravel.
Douglas	147,000	74,000	Sand and gravel.
Faribault	427,000	410,000	Do.
Fillmore	W	W	Iron ore, stone, sand and gravel.
Freeborn	164,000	314,000	Sand and gravel.
Goodhue	553,889	385,781	Stone, sand and gravel, clays.
Grant	45,000	137,000	Sand and gravel.
Hennepin	3,809,157	4,299,500	Sand and gravel, clays.
Houston	W	96,696	Stone, sand and gravel.
Hubbard	151,000	35,000	Sand and gravel.
Isanti	33,000	41,000	Do.
Itasca	74,828,569	71,644,513	Iron ore, sand and gravel, peat.
Jackson	188,000	107,000	Sand and gravel.
Kanabec	271,145	619,700	Sand and gravel, stone.
Kandiyohi	249,000	369,000	Sand and gravel.
Kittson	121,000	49,000	Do.
Koochiching	46,000	87,000	Do.
Lac qui Parle	784,415	520,852	Stone, sand and gravel.
Lake	103,000	115,000	Sand and gravel.
Lake of the Woods	137,000	108,000	Do.
Le Sueur	1,688,266	1,868,972	Sand and gravel, stone.
Lincoln	W	173,000	Sand and gravel.
Lyon	261,000	213,000	Do.
McLeod	123,000	143,000	Do.
Mahnomen	35,000	W	Do.
Marshall	155,000	195,000	Do.
Martin	168,000	254,000	Do.
Meeke	159,000	W	Do.
Mille Lacs	W	283,100	Stone, sand and gravel.
Morrison	80,000	193,000	Sand and gravel.
Mower	473,284	577,683	Stone, sand and gravel.
Murray	W	79,000	Sand and gravel.
Nicollet	351,320	569,095	Sand and gravel, stone.
Nobles	W	119,000	Sand and gravel.
Norman	247,000	146,000	Do.
Olmsted	1,116,579	646,685	Stone, sand and gravel, iron ore.
Otter Tail	802,310	752,000	Sand and gravel, peat.
Pennington	41,000	183,000	Sand and gravel.
Pine	146,600	79,975	Sand and gravel, peat.
Pipestone	185,000	W	Sand and gravel.
Polk	1,409,323	1,002,014	Sand and gravel, lime.
Pope	192,000	88,000	Sand and gravel.
Ramsey	805,250	706,500	Sand and gravel, clays.
Red Lake	23,000	61,000	Sand and gravel.
Redwood	369,619	373,350	Sand and gravel, stone, clays.
Renville	415,937	531,600	Stone, sand and gravel.
Rice	617,975	344,154	Sand and gravel, stone.
Rock	576,186	588,410	Sand and gravel, abrasives, stone.
Roseau	74,000	129,000	Sand and gravel.
St. Louis	377,761,742	389,850,510	Iron ore, cement, sand and gravel, lime, stone, peat.
Scott	818,370	1,270,998	Stone, sand and gravel.
Sherburne	82,000	143,000	Sand and gravel.
Sibley	77,000	157,000	Do.
Stearns	4,208,021	3,049,741	Stone, sand and gravel.
Steele	312,360	436,414	Sand and gravel, stone.
Stevens	161,000	W	Sand and gravel.
Swift	294,000	113,000	Do.
Todd	139,000	119,000	Do.
Traverse	78,000	21,000	Do.

See footnotes at end of table.

**Table 14.—Value of mineral production in Minnesota, by counties—Continued**

County	1964	1965	Minerals produced in 1965 in order of value
Wabasha.....	\$172,290	\$160,646	Stone, sand and gravel.
Wadena.....	36,930	61,280	Sand and gravel, stone.
Waseca.....	23,000	20,000	Sand and gravel.
Washington.....	2,155,310	2,506,529	Sand and gravel, stone.
Watowan.....	148,000	W	Sand and gravel.
Wilkin.....	W	42,000	Do.
Winona.....	1,095,581	896,943	Stone, sand and gravel.
Wright.....	197,000	33,000	Sand and gravel.
Yellow Medicine.....	413,661	399,000	Stone, sand and gravel.
Undistributed <sup>1</sup> .....	4,760,892	6,209,299	
Total.....	497,495,000	507,760,000	

W Withheld to avoid disclosing individual company confidential data; included with "Undistributed."

<sup>1</sup> Includes some sand and gravel and stone that cannot be assigned to specific counties, and values indicated by symbol W.

by six companies and the State highway department using fixed and portable plants near Felton, Glyndon, Hawley, Moorhead, and Sabin. Output was used for road construction, building, and other uses. The county highway department contracted for paving gravel.

**Cook.**—Erie Mining Co. shipped nearly 8 million tons of taconite pellets from Taconite Harbor. Pellets were produced at Erie's processing plant near Hoyt Lakes, St. Louis County. First cargo of the 1965 season was loaded April 21, and the final cargo left Taconite Harbor on December 9.

Sand and gravel (450,000 tons) was produced chiefly for building and road construction. Portable plants were operated by:

The Hanna Mining Co..... Algoma and Robert.  
 Inland Steel Co..... Armour No. 2.  
 Pickands Mather & Co..... Rabbit Lake.  
 Pittsburgh Pacific Co..... Hopkins, Mangan No. 1, Sagamore, and Sultana.

The above mines were open pits with the exception of the Armour No. 2 underground mine. About 67 percent of the iron ores shipped was classed as direct shipping; the remainder was concentrate. The Hanna Mining Co. shipped from stockpiles at the Robert mine. The Algoma mine, stripped during the 1964-65 winter season, was Hanna's major producer in the county. The Hanna Mining Co. purchased the Rabbit Lake mine, formerly operated by Pickands Mather & Co., late in 1965 and announced plans to construct a beneficiation plant. The plant was scheduled to be operational during the 1966 shipping season. Pittsburgh Pacific

Co. operated the Sagamore mine and shipped Hopkins, Mangan No. 1, and Sultana stockpile concentrates.

Les Roberts Sand, Gravel & Excavating Co., and Ripley Sand & Gravel, Inc., operated fixed sand and gravel plants near Brainerd and produced material for road construction, building, fill, and other uses. C. L. Stodolka Co., Inc., operated a portable plant near Brainerd and produced paving gravel. The county highway department produced and contracted for paving gravel.

**Crow Wing.**—Shipments of manganiferous ore increased about 49 percent from those of 1964, whereas iron ore shipments decreased 32 percent. Major reason for the increase in manganiferous ore shipments was the reopening of the Algoma mine. The decrease in iron ore shipments was attributed to the temporary closure of the Rabbit Lake mine early in the shipping season.

Operating companies and mines from which iron and/or manganiferous ores were shipped were as follows:

#### Mines

Co. operated the Sagamore mine and shipped Hopkins, Mangan No. 1, and Sultana stockpile concentrates.

Les Roberts Sand, Gravel & Excavating Co., and Ripley Sand & Gravel, Inc., operated fixed sand and gravel plants near Brainerd and produced material for road construction, building, fill, and other uses. C. L. Stodolka Co., Inc., operated a portable plant near Brainerd and produced paving gravel. The county highway department produced and contracted for paving gravel.

**Dakota.**—Sand and gravel production increased substantially to 2.3 million tons. Output was used for building, road con-

struction, fill, and other uses. Portable plants were operated by Alexander Construction Co., Inc., Bituminous Surface Treating Co., Fischer Construction Co., Inc., Kimmes-Bartelma Construction Co., Inc., Edward Kraemer & Sons, Inc., and Solberg Construction Co. Fischer Sand & Aggregate Co., Inc., Northwestern Gravel Co., Inc., and Standard Building Material Co. operated fixed plants at Rosemont, Savage, and South St. Paul, respectively. The State and county highway departments produced and contracted for sand and gravel for road construction. Edward Kraemer & Sons, Inc., produced crushed limestone for roadstone and agricultural use. Byproduct sulfur was recovered by Great Northern Oil Co. at its Pine Bend refinery.

**Faribault.**—About 431,000 tons of paving gravel was produced by H. R. Loveall Construction Co. near Winnebago and by contractors for the Faribault County and Winnebago County, Iowa, highway departments. The 10-percent decrease in production was attributed to lack of purchases by the State highway department.

**Fillmore.**—Iron ore shipments from Fillmore County mines were 556,410 tons, 54 percent greater than in 1964. Virtually the entire output was shipped by rail to consuming furnaces at Granite City, Ill. The Hanna Mining Co. shipped 517,440 tons from its Spring Valley mine group. Schroeder Mining Co. shipped from the Evers, Hilsapple and Van Sande properties.

About 378,000 tons of crushed limestone was produced by six companies operating fixed and portable plants near Harmony, Ostrander, Preston, and Spring Valley. The greater portion of the 59-percent gain in production was due to increased road construction activity. Demand for agricultural limestone also increased.

Approximately 35,000 tons of sand and gravel was produced. Fixed plants were operated by Allen Thompson at Rushford and Bothun & Torgerson Sand & Gravel Co. at Lanesboro. The State highway department produced paving sand and gravel.

**Goodhue.**—Red Wing Sewer Pipe Corp. produced plastic fire clay to manufacture vitrified sewer pipe. The company operated two pits, Bellchester and North Star, near Goodhue. About 161,000 tons of sand and gravel was produced by nine companies and contractors for the State

and county highway departments. The material was used for building, road construction, fill, and other uses. Fixed and portable plants were operated near Cannon Falls, Frontenac, Lake City, Pine Island, Red Wing, and Zumbrota. The sand and gravel operation of Lester W. Cordes near Red Wing was sold to John Savage.

About 213,000 tons of crushed limestone was produced, a 17-percent gain over 1964 figures. Kielmeyer Construction Co. operated a portable plant near Kenyon and produced roadstone. Mann Construction Co. operated portable plants at various locations for road construction material, agricultural limestone, and riprap. Quarve & Anderson Co. and Valley Limestone Co. operated a portable and fixed plant at Goodhue and Zumbrota, respectively, and produced crushed limestone for road construction and agricultural use.

**Hennepin.**—Total value of mineral production increased 13 percent over that of 1964, primarily because of a 1.4-million-ton increase in sand and gravel production for freeway construction. A total of 5.7 million tons of sand and gravel was produced by 16 companies at fixed and portable plants in various Minneapolis suburban areas. Output was used for road construction, building, fill, and other uses. Commercial operators included Alexander Construction Co., Inc.; Anderson Aggregates, Inc.; Barton Contracting Co. (Commercial Aggregate, Inc.); Consolidated Materials Co. (Hedberg & Sons Co.); J. A. Danens & Son, Inc.; Duininck Bros. & Gilchrist; Chas. M. Friedheim Co.; Glacier Sand & Gravel Co.; Hedberg & Sons Co.; Hopkins Sand & Gravel Co. (Woodrich Construction Co.); Keller Bros. Gravel Co.; Mapco Sand & Gravel Co.; Mound Sand & Gravel Co., Inc.; R. J. Porter, Inc.; Oscar Roberts Co.; and J. L. Shiely Co.

The State and county highway departments produced and/or contracted for sand and gravel for road construction purposes.

Clay was produced by North Central Lightweight Aggregate Co., Inc., and used to make sintered lightweight aggregate.

Exfoliated vermiculite was produced at Minneapolis by B. F. Nelson Manufacturing Co. and Western Mineral Products Co. for crude material mined in Montana. Output was sold for building insulation, plaster and concrete aggregate, litter, fireproofing, acoustical, and other uses. Expanded

perlite was produced by Western Mineral Products Co. and Minnesota Perlite Corp. from crude perlite mined in Nevada and New Mexico. Output was sold for light-weight aggregate in concrete and plaster, filler, soil conditioning, texture paint, and other uses.

**Houston.**—Hector Construction Co., Inc. operated portable crushing plants at six limestone quarries and produced 65,000 tons of roadstone and agricultural limestone, as well as 3,000 tons of paving sand from a pit near Houston. Crushed limestone for roadstone was produced at three quarries near Hokah, two operated by

Company:

Cleveland-Cliffs Iron Co.-----	Canisteo, Hawkins, Hill-Trumbull, Holman-Cliffs, and Sally.
The Hanna Mining Co.-----	Harrison group, Hunner, Mississippi group, and Patrick group.
Jones & Laughlin Steel Corp.---	Hill Annex and Lind-Greenway.
Pickands Mather & Co.-----	Danube and West Hill.
United States Steel Corp.-----	Arcturus and Plummer.

The Hanna Mining Co. was constructing two magnetic taconite plants near Cooley and Keewatin with a combined initial annual capacity of 4.4 million tons of pellets. The National Steel Pellet Co. plant near Keewatin, with annual capacity of 2.4 million tons of pellets, was scheduled for operation in 1967. National Steel Corp. had an 85-percent interest in the project and The Hanna Mining Co. had a 15-percent interest. The 2-million-ton annual capacity Butler Taconite plant under construction at Cooley was scheduled for operation early in 1967. Participating in the project with The Hanna Mining Co. were Inland Steel Corp. and Wheeling Steel Corp. Production will be shared on a percentage of ownership basis. Hanna continued studies of methods of reducing normal iron oxide pellets to the prereduced form as part of a research program conducted jointly with National Steel Corp. and Surface Combustion Division of Midland-Ross Corp.

The Jessie H. Mining Co. operated the Jessie mine. All ore produced was placed in stockpiles. Cleveland-Cliffs Iron Co. depleted stockpiles at the Hawkins mine by the end of the shipping season.

Pacific Isle Mining Co. closed the St. Paul mine. At the end of the shipping season The Hanna Mining Co. discontin-

ued mining operations at the Mississippi group.

**Itasca.**—The county mineral output, representing 14 percent of the State total value, decreased 4 percent, primarily because of a decrease in iron ore shipments. The use of taconite pellets and high-grade foreign ores in the steel industry reduced the demand for natural ores. All mines operated were open pits. About 99 percent of the usable iron ore shipments were concentrate. Operating companies and mines from which iron ore was shipped were as follows:

#### Mines

ued mining operations at the Mississippi group.

About 350,000 tons of sand and gravel was produced. Output was used for road construction, building, and other uses. Commercial plants were operated by Brink Sand & Gravel Co. (formerly Neil Baker Co.) and Hawkinson Construction Co., Inc., at Grand Rapids. The State and county highway departments produced and contracted for sand and gravel for road construction.

Arrowhead Peat Co. produced peat for horticultural use from a bog near Wawina.

**Kanabec.**—Granite quarried by the Cold Spring Granite Co. at its Mora Gray quarry was processed at the company's Cold Spring plant and sold for architectural and monument purposes. About 969,000 tons of sand and gravel was produced by three commercial producers and two governmental units, operating portable plants near Isle, Mora, and Ogilvie. The material was used chiefly for road construction.

**Lac qui Parle.**—Bellingham Granite Co. and Dakota Granite Co. quarried granite near Bellingham for monument purposes. Cold Spring Granite Co. quarried granite at its Red quarry near Odessa and shipped rough stone to its Cold Spring plant for processing. Output was for architectural and monument purposes. North Star

Granite Corp. quarried granite near Bellingham. The rough stone was finished at the company's plant at St. Cloud for monument purposes. Northern Quarry Corp. quarried granite at Louisburg for monument purposes.

About 108,000 tons of sand and gravel was produced by Johnson Road Co., Inc., from two pits near Dawson and Montevideo and by W. J. Stolpman at a fixed plant near Rosen. Output was for paving, building, and fill. The State and county highway departments produced and contracted for sand and gravel for road construction purposes.

**Lake.**—Reserve Mining Co. operated its large taconite plant at Silver Bay and produced a record 10 million tons of iron ore pellets, 4 percent greater than in 1964, from about 29 million tons of crude ore mined at the Peter Mitchell mine at Babbitt, St. Louis County. Reserve constructed a \$5 million research laboratory at Silver Bay.

Geologists representing major mining companies were actively investigating the potential of the copper-nickel occurrences in the Duluth Gabbro. This formation along the Kawishiwi River had been explored by the Bureau of Mines in 1951 and in 1953 and the results of the investigation were published.<sup>4</sup>

Two Harbors Aggregate Co. and Ulland Bros., Inc., operated plants at Two Harbors and Isabella, respectively, and produced a total of 15,000 tons of sand and gravel for road construction, building, and fill. The State and county highway departments produced and/or contracted for 170,000 tons of paving sand and gravel.

**Le Sueur.**—The Babcock Co. produced dimension limestone near Kasota. Principal products were cut stone and stone veneer. A portion of the product was marketed as marble for interior trim and facings. A fire damaged the company's stone sawing building early in May. Ed. Swartout produced limestone for use as roadstone and riprap at a quarry near Kasota.

Approximately 1.1 million tons of sand and gravel was produced. Silica sand was produced near Le Sueur by Gopher State Silica, Inc., and sold for glass manufacture, molding, oil-field fracturing, filler, and building. Sand and gravel for construction purposes was produced near Ka-

sota, Le Center, and Le Sueur by Glander Sand & Gravel Co., Kielmeyer Construction Co., Lundin Construction Co., Inc., and Ed. Swartout. The State and county highway departments produced and/or contracted for sand and gravel for road construction.

**Mille Lacs.**—Cold Spring Granite Co. quarried granite at its Diamond Grey quarry near Isle. The rough stone was processed at the company's Cold Spring plant. Mille Lacs Sand & Gravel Co. produced 22,000 tons of sand and gravel at a fixed plant at Milaca. Output was used for building and paving. The Isanti County, Mille Lacs County, and the State highway departments produced and/or contracted for 88,000 tons of sand and gravel for road construction.

**Mower.** Value of mineral production in Mower County increased 22 percent over that of 1964, chiefly because of increased production of limestone for roadstone and agricultural use. Four companies produced a total of 353,000 tons of limestone. The material was used for roadstone, agricultural purposes, fluxstone, fertilizer, and poultry grit. Operating portable plants were Osmundson Bros. at Le Roy and Grand Meadow and Quarve & Anderson Co. at Lyle. Martin Bustad & Son and Hickok Calcium White Rock Co. operated fixed plants at Austin and Le Roy, respectively.

About 251,000 tons of sand and gravel was produced for road construction, building, and other uses. Five commercial companies operated fixed and portable plants near Adams and Austin. The county highway department contracted for paving gravel.

**Nicollet.**—Value of mineral production increased 62 percent over that of 1964 principally because of increased production of sand and gravel for county highway construction. Approximately 542,000 tons of sand and gravel was produced. Courtland Ready Mix Co., Hallett Construction Co., and North Star Concrete Co. operated fixed sand and gravel plants at Courtland, St. Peter, and Judson, respectively, and produced material for building and road construction. Paving sand and gravel was

<sup>4</sup> Grosh, W. A., J. W. Pennington, P. A. Wason, and S. R. B. Cooke. Investigation of Copper-Nickel Mineralization in Kawishiwi River Area, Lake County, Minn. BuMines Rept. of Inv. 5177, 1955, 18 pp.



produced by the State highway department and under contract for the Nicollet and Sibley County highway departments.

New Ulm Quartzite Quarries, Inc., produced crushed quartzite at a fixed plant near New Ulm. Production was sold for concrete aggregate, refractories, poultry grit, riprap, and other uses.

**Olmsted.**—Value of mineral production decreased 42 percent from that of 1964 chiefly because of lesser quantities of sand and gravel and iron ore produced. Schroeder Mining Co. produced iron ore from the Baker property near Chatfield. Most of the output was shipped by rail to consuming furnaces at Granite City, Ill. A portion was used in cement manufacture. The company's Bernard and Partello properties, from which production was reported in 1964, were inactive. About 365,000 tons of sand and gravel, a decrease of 39 percent from 1964 figures, was produced. The material was used for building, road construction, fill, and other uses. Operating fixed plants at Rochester were Quarve & Anderson Co., Riverside Sand & Gravel Co., and Rochester Sand & Gravel, Inc. The county highway department and city of Rochester contracted for sand and gravel for highway maintenance and construction. Quarve & Anderson Co. operated portable plants at five quarries and produced crushed limestone for roadstone and agricultural use.

**Otter Tail.**—About 1.3 million tons of sand and gravel was produced for road construction, building, railroad ballast, and other uses. Commercial producers included John Dieseth Co.; Thomas Leo Horstman; K. & G. Aggregates, Inc.; Mark Sand & Gravel Co.; J. D. Nelson Excavating Co.; and Soo Line Railroad Co. Plants were operated near Battle Lake, Bluffton, Fergus Falls, Underwood, and Vergas. The State and county highway departments produced and contracted for paving sand and gravel. Northland Peat Co. produced peat for soil improvement from a bog near Underwood.

**Polk.**—Value of mineral production decreased 29 percent from that of 1964 because of decreased production of sand and gravel. About 750,000 tons of sand and gravel was produced for road construction, building, railroad ballast, fill, and other uses. Commercial operators included Jay W. Craig Co.; Great Northern Railway

Co.; Mahnomen Construction Co.; Northern Sand & Gravel, Inc.; Spring Gravel Co.; Thorson Gravel Co.; and Tuseth Gravel & Construction Co.

The State highway department produced sand and gravel for road construction purposes. The Polk and Red Lake County highway departments contracted for paving gravel. The American Crystal Sugar Co. produced quicklime at Crookston and East Grand Forks, using shaft kilns with coke as fuel. Output was used for sugar refining.

**Ramsey.**—Approximately 712,000 tons of sand and gravel was produced for building, road construction, and other uses. Arsenal Sand & Gravel Co. and Lange Bros. Building Materials Co. operated fixed plants at New Brighton and St. Paul, respectively. Jay W. Craig operated a portable plant near New Brighton. The State highway department contracted for paving sand and gravel.

The Sebesta Stone Co. quarry in St. Paul was taken for freeway right of way. Twin City Brick Co. produced about 27,000 tons of shale for building brick manufacture. The MacArthur Co. produced exfoliated vermiculite at its St. Paul plant from crude vermiculite mined in Montana. The exfoliated product was sold as building insulation, plaster and concrete aggregate, and steampipe insulation.

**Redwood.**—About 620,000 tons of sand and gravel, 16 percent more than in 1964, was produced for road construction, building, fill, and other uses. Chapman Sand & Gravel Co. and Walnut Washed Sand & Gravel Co. operated fixed plants at Belview and Walnut Grove, respectively. Duinick Bros. & Gilchrist and Werner & Unzeitig operated portable plants. The Redwood and Yellow Medicine highway departments produced and/or contracted for paving gravel. Johnson Quarry Co. and View Quarry Co. quarried granite near Belview for monuments. Ochs Brick & Tile Co. produced miscellaneous clay near Redwood Falls for processing at its Springfield brick plant.

**Renville.**—Approximately 390,000 tons of sand and gravel was produced, a 30-percent increase over that of 1964. Commercial producers included Danube Washed Sand & Gravel Co.; Duinick Bros. & Gilchrist; John Enestvedt Gravel Pit; Fairway Construction Co.; Johnson Road Co.,

Inc.; and Morton Aggregates, Inc. Operations were near Danube, Granite Falls, Hector, Morton, and Sacred Heart. Output was used for road construction, building, fill, and other uses. The county highway department produced and contracted for paving gravel.

Cold Spring Granite Co. quarried granite at its Rainbow quarry near Morton for architectural and monument purposes. The rough stone was processed at the company's Cold Spring plant.

**Rice.**—Limestone was produced by Bryan Rock Products, Inc., B. H. Heslerton Co. (formerly Faribault Quarries), and Kiemeyer Construction Co. at portable plants near Northfield, Faribault, and Nerstrand, respectively. The material was used for roadstone, agricultural purposes, and riprap. About 431,000 tons of sand and gravel, a 51-percent decrease from 1964 figures, was produced from operations near Dundas, Faribault, and Northfield. The decrease was attributed to reduced road construction activity. Commercial operators included Charles W. Bickel; Condon Sand & Gravel; Jay W. Craig Co.; Hallett Construction Co.; Kiemeyer Construction Co.; Kimmes-Bartelma Construc-

tion Co., Inc.; and Owatonna Aggregates Corp. The Rice County, Waseca County, and State highway departments contracted for paving sand and gravel.

**Rock.**—Jasper Stone Co. produced grinding pebbles and tube-mill liners from a quartzite quarry near Jasper. Some stone was sold for riprap. About 489,000 tons of sand and gravel was produced in the county. Hallett Construction Co. and Pronk & Son operated fixed plants at Luverne and Leota, respectively. C. H. Hatting Gravel Co., Inc., operated a portable plant near Luverne. Output was used for road construction, building, fill, and other uses. The county highway department contracted for paving gravel.

**St. Louis.**—The value of St. Louis County mineral production increased 3 percent over that of 1964 and represented about 77 percent of the State total. The principal reason for the gain was a 5-percent increase in shipments of iron ore, which contributed 98 percent of the total county mineral production value. St. Louis County mines shipped 80 percent of the total iron ore shipped from the State. Operating companies shipping iron ore in 1965 were:

#### Mesabi Range:

The Hanna Mining Co.-----	Agnew No. 2-South Agnew, Douglas, East Alpena, Morton-South Eddy, and Pierce group.
Inland Steel Co.-----	Dean and Itasca.
Jones & Laughlin Steel Corp.----	Schley group.
Pacific Isle Mining Co.-----	Higgins No. 2.
Pickands Mather & Co.-----	Erie Commercial and Mahoning.
Pittsburgh Pacific Co.-----	Albany Lean-ore Stockpile, Arne, Corsica Lean-ore Stockpile, Leonidas, Lincoln, Minnewas, Nelson, Spruce, South Stevenson, Stevenson Reserve, Susquehanna Lean-ore Stockpile, Wyoming, and Wyoming Annex.
Reserve Mining Co.-----	Peter Mitchell.
Rhude & Fryberger-----	East Bay, Hull, Security, and Wade.
Snyder Mining Co.-----	Shenango, Wanless, Whiteside, and Woodbridge.
United States Steel Corp.-----	Burt Stockpile No. 41, Kosmerl, Pilotac, Rouchleau group, Sherman group, Spruce Stockpile, and Stephens.

#### Vermilion Range:

United States Steel Corp.-----	Pioneer.
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The only operating underground mine in the county at the close of the year was the Pioneer mine of United States Steel Corp. at Ely. At yearend, a number of open pit mines were closed, including the Weggum (The Hanna Mining Co.); Bennett Annex (Pickands Mather & Co.); and

#### Mines

the Brunt, Iroquois, and Wacootah (Pacific Isle Mining Co.). The Hanna Mining Co. discontinued mining operations at the Morton mine; some ore remained in stockpile at yearend. Leases cancelled at end of season included the Cloquet Lean-ore Stockpile and the Missabe Mountain

mine. Pittsburgh Pacific Co. reopened the Higgins No. 2 and opened a new mine, the Arne, at Aurora. Both mines were natural ore operations.

The United States Steel Corp. 4.5-million-ton taconite plant under construction on the Continental Divide north of Mountain Iron was scheduled for completion in 1967. United States Steel Corp. continued operations at its Pilotac taconite plant near Mountain Iron. Concentrate was shipped to its Extaca plant near Virginia for agglomerating.

The Eveleth Taconite Co., owned by Ford Motor Co. (85 percent) and Oglebay Norton Co. (15 percent), completed construction of its 1.6 million ton annual capacity concentrator. The Fairlane concentrator located 10 miles south of the company's Thunderbird mine received its first crude taconite shipment in November. Pellets were first produced in December and were stockpiled at the Duluth Missabe and Iron Range Railway's new Lakehead bulk storage facility at Duluth for Lake shipment the following season. The Lakehead storage facility was built to provide pellet storage for United States Steel Corp.'s Mountain Iron plant as well as the Fairlane plant. The facility was also designed to discharge and stockpile coal.

A \$50 million expansion program at Erie Mining Co.'s taconite plant at Hoyt Lakes was in progress. Annual capacity will be increased 2.8 million tons to 10.3 million tons of pellets. Development work at the new Dunka River taconite mine, which will supplement Erie's crude ore supply, has been completed.

More than 37 percent of the State total iron ore output was taconite concentrate. Erie Mining Co. (Pickands Mather & Co., operating agents) produced a record 8.0 million tons of taconite pellets at its Hoyt Lakes plant. The taconite pellets were hauled 73 miles on the company-owned railroad to Erie's shipping port at Taconite Harbor.

Reserve Mining Co. mined more than 29 million tons of crude taconite at its Peter Mitchell mine near Babbitt. The crude material was crushed to about 3-inch size at the mine site and hauled over an interplant railroad to Silver Bay, Lake County, for processing. Jones & Laughlin Steel Corp. proposed 2-million-ton-per-

year taconite pellet plant near Biwabik is in the design stage.

The Hanna Mining Co.'s leading shipper was the Pierce group at Hibbing. The South Agnew and Agnew No. 2 properties were also important producers.

Major producing mines operated by United States Steel Corp., in order of tonnage produced, were the Sherman group, Stephens, Rouchleau group, Pilotac, Pioneer, and Kosmerl. Company production in the county increased 5 percent over that of 1964. Pittsburgh Pacific Co. shipped from 13 properties. Shipments were 57 percent over those of 1964. During the year, Pittsburgh Pacific acquired the Minnewas mine (formerly operated by E. A. Young). Rhude & Fryberger operated the Hull mine (formerly part of United States Steel Corp. famed Hull-Rust group) and shipped from stockpile at the East Bay, Security, and Wade mines.

American Steel and Wire Division of United States Steel Corp. produced basic pig iron and steel at Duluth. During periods of maximum production, two blast furnaces were operated. Nine open hearths were available for steel production. Production increased slightly over that of 1964.

Universal Atlas Cement Division of United States Steel Corp. produced portland and masonry cements at its plant in Duluth. Michigan limestone and blast furnace slag were used in the manufacturing process. The firm was the only cement producer in the State. Cutler-Magner Co. produced quicklime and hydrated lime at Duluth from limestone mined in Michigan. Products were used for paper manufacturing, steelmaking, water purification and softening, and other uses.

Hallett Mineral Co. was formed to process crude bentonite from Montana for use in pelletizing taconite concentrates. The company's plant will be located at Burnett.

Mesabi Grow Co., Inc. (formerly St. Louis County Peat Products Co.) produced peat near Central Lakes and sold it mainly for soil improvement and other horticultural purposes.

Sand and gravel was produced by 13 commercial companies and the State and county highway departments. About 3.1 million tons, a 26-percent increase over 1964 figures, were produced for road construction, building, railroad ballast, and fill.

The Zenith Dredge Co. produced crushed basalt near Duluth for concrete aggregate and roadstone.

**Scott.**—Approximately 416,000 tons of crushed limestone, about double 1964 production, was produced near Shakopee for roadstone, railroad ballast, asphalt filler, agricultural use, and riprap. Producing companies were Bryan Rock Products, Inc., B & R Rock Products, and J. L. Shiely Co. Sand and gravel production increased substantially to about 441,000 tons. Commercial operators included Belle Plaine Sand & Gravel Co.; Jay W. Craig Co.; Haferman & Stark, Inc.; Hallett Construction Co.; Minnesota Quartz Co.; Shakopee Sand & Gravel Co.; and Wissota Sand & Gravel Co. Plants were operated near Belle Plaine, Chaska, Jordan, New London, and Shakopee. The State and county highway departments produced paving sand and gravel.

**Stearns.**—Mineral production value dropped 28 percent from that of 1964 primarily because of lesser production of granite for architectural stone. Cold Spring Granite Co. produced granite at six quarries near Cold Spring, Rockville, St. Cloud, and St. Joseph. The rough blocks were processed at the company's finishing plants in St. Cloud and Cold Spring. Some material was crushed at the Cold Spring plant and sold for poultry grit. Delano Granite Works, Inc., operated its Rockville quarry and shipped the rough granite to its plant at Delano for processing. Output was sold for monument and architectural use. North Star Granite Corp. produced granite from the Minnesota Pink and Pioneer Gray quarries near St. Cloud and processed the stone at its St. Cloud finishing plant for use as monuments. Shiely-Petters Crushed Stone Co., Inc., produced crushed granite near Waite Park for use as railroad ballast, roadstone, stone sand, and other uses.

Sand and gravel was produced at fixed plants near St. Cloud and Richmond by A. C. Petters Co., Inc., and Richmond Sand & Gravel Co., respectively. Output was used for building and road construction. The State and county highway departments produced and contracted for paving sand and gravel.

**Washington.**—About 2.3 million tons of

sand and gravel was produced for road construction, building, fill, and other uses. Commercial producers included Alexander Construction Co., Inc.; Cemstone Products Co.; Jay W. Craig Co.; R. J. Jager Gravel Co.; Kimmes-Bartelma Construction Co., Inc.; Carl Olinger; Shalander & Shaleen; and J. L. Shiely Co. The county highway department produced paving sand. Moelster Construction Co., Inc., a producer in 1964, sold its gravel pit to Northern States Power Co.

Limestone for roadstone, agricultural purposes, and riprap was produced by Bryan Rock Products, Inc., at Marine-on-St. Croix, Nienaber Contracting Co. near Lake Elmo, and J. L. Shiely Co. at St. Paul Park.

**Winona.**—Value of mineral production decreased 18 percent to about \$897,000, chiefly because of a lessening of road construction. Dimension limestone was produced by Biesanz Stone Co., Inc., at its Winona quarry, chiefly for architectural use. Crushed limestone for roadstone, agricultural use, and riprap was produced by Lloyd DeBold, Fred Fakler, Hector Construction Co., Inc., Patterson Quarries, Inc., and Quarve & Anderson Co. Quarries were operated near Dresbach, Lewiston, Pickwick, Ridgeway, Rollingstone, St. Charles, Wilson, Winona, and Witoka.

**Wright.**—Delano Granite Works, Inc., operated a sawing and finishing plant at Delano, processing granite blocks quarried by the company in Big Stone and Stearns Counties. The State and county highway departments produced and/or contracted for 53,000 tons of paving sand and gravel.

**Yellow Medicine.**—Crushed and broken granite for railroad ballast was produced near Granite Falls by The Green Co. The Signet Quarry Co., inactive since 1963, leased its quarry to the Delano Granite Co. A few test blocks were quarried. About 241,000 tons of sand and gravel for road construction, building, fill, and other uses was produced. Deutz & Crow Co., Inc., operated a fixed plant at Canby. John Dieseth Co., Johnson Road Co., Inc., and Megarry Bros., Inc., operated portable plants near Canby, Clarkfield, and Granite Falls. The State and county highway departments contracted for paving sand and gravel.