

# THE MINERAL INDUSTRY OF MINNESOTA

Minnesota remained eighth among the 50 States in total nonfuel mineral production value<sup>1</sup> in 1997, according to the U.S. Geological Survey (USGS). The estimated total nonfuel mineral value for the State in 1997 was almost \$1.6 billion, a 4% increase from that of 1996. This followed a marginal increase from 1995 to 1996 (based on final 1996 data). The State accounted for 4% of the U.S. total nonfuel mineral production value.

In 1997, iron ore accounted for more than 83% of the State's nonfuel mineral production value, while construction sand and gravel and crushed stone accounted for about 10% and 4%, respectively. In 1997, whereas nearly all nonfuel minerals increased in value, the 50% or \$54 million increase in the value of construction sand and gravel accounted for most of the State's rise in nonfuel mineral production value (table 1).

Compared to USGS estimates of quantities produced in the other 49 States in 1997, Minnesota remained 1st in the Nation in iron ore and 10th in industrial sand. The State rose from sixth to fourth in the production of peat and from ninth to fifth in construction sand and gravel. Additionally, the State produced significant quantities of crushed stone and dimension stone.

The following narrative information was provided by the Minnesota Department of Natural Resources' Minerals Division (MDNRMD).<sup>2</sup> The State of Minnesota issued 14 nonferrous metallic mineral leases in 1997. Twelve leases, covering 2,175 hectares, were issued through public lease sale and cover lands in Aitkin, Beltrami, Crow Wing, and Lake of the Woods Counties. The first lease was issued through the new preference rights leasing system, under which State lands are continually available for leasing after having first been offered through public sale. A negotiated lease was issued to Lehmann Exploration Management, Inc. for a portion of the bed of Birch Lake on the border of Lake and St. Louis Counties. Exploration has been conducted for platinum-group metals in this terrane, which is part of the base of the Middle Proterozoic mafic layered Duluth Complex.

Exmin, Cominco Ltd., and the American Shield Co. drilled a total of eight exploratory holes in Aitkin, Beltrami, Koochiching, Marshall, and St. Louis Counties. These companies are exploring

<sup>1</sup>The terms "nonfuel mineral production" and related "values" encompass variations in meaning, depending on the minerals or mineral products. Production may be measured by mine shipments, mineral commodity sales, or marketable production (including consumption by producers) as is applicable to the individual mineral commodity.

All 1997 USGS mineral production data published in this chapter are estimates as of January 1998. For some commodities (for example, construction sand and gravel, crushed stone, and portland cement), estimates are updated periodically. To obtain the most current information, please contact the appropriate USGS mineral commodity specialist. Call MINES FaxBack at (703) 648-4999 from a fax machine with a touch-tone handset, and request Document # 1000 for a telephone listing of all mineral commodity specialists, or call USGS information at (703) 648-4000 for the specialist's name and number. This telephone listing may also be retrieved over the Internet at <http://minerals.er.usgs.gov/minerals/contacts/comdir.html>. All Mineral Industry Surveys—mineral commodity, State, and country—also may be retrieved by way of MINES FaxBack or over the Internet at <http://minerals.er.usgs.gov/minerals/>.

<sup>2</sup>Maryanna Harstad, Senior Planner, authored the text of State mineral industry information provided by the MDNRMD.

for diamond, and for base and precious metals. MDNRMD drilled five bedrock holes in Aitkin and St. Louis Counties. Core from these holes was used to evaluate a dimension stone prospect and a granite prospect, and to evaluate mineral potential of the Early Proterozoic greenstones in Central Minnesota and the western contact of the Duluth Complex.

A multi-agency committee was formed to encourage new mineral exploration in Minnesota. The committee released a new brochure titled "Take a New Look at Minnesota Minerals!". The committee also compiled information for a *Mining Journal* supplement due out in early 1998. In addition, the Iron Range Resources and Rehabilitation Board offered its Drilling Incentive Grant Program, which matches up to 40% of direct drilling costs, but not to exceed a match of \$20,000.

A heavy minerals study of glaciofluvial sediments was completed in cooperation with the USGS covering different bedrock geological terranes. Three potential mineral-resource areas have been identified for eventual follow-up.

A preliminary geologic map of the Allen Quadrangle, which straddles the Middle Proterozoic Duluth Complex basal contact along with accompanying gravity and aeromagnetic data, illustrates the geology, structure, and related copper, nickel, and iron-titanium mineralization within the area. This was a collaboration between staff at the Natural Resources Research Institute and the Minnesota Geological Survey.

Studies are in progress by the University of Minnesota Duluth (UMD) to assess the gold and volcanogenic massive sulfide potential of selected greenstone terranes of the northeastern portion of the State. A geographical information systems approach has been taken for evaluating these types of mineralization in the State. This methodology has led to the preliminary recognition of three areas with potential mineralization.

State agencies, mineral industry, and academia have embarked on a cooperative effort to improve access to archived mineral exploration data. The cornerstone for this improved access is the object-based exploration and product model that guides users through and across State mineral leasing, drill core, exploration, and applied research files.

The iron mining industry in Minnesota remained strong with seven taconite plants producing more than 46 million metric tons of iron concentrates in pellet form. US Steel Group USX (Minntac) expanded its domestic iron ore production at its 7.2-kilometer-long west pit. Permits were granted and operations commenced in the fall of 1997 after completion of an environmental assessment worksheet and negotiated agreements, lease transfers, and new leases between Minntac, Ontario Iron Co., and the State of Minnesota.

The Iron Ore Cooperative Research Committee—made up of representatives from producers, research labs, and State governments—selected process and concentrator modeling as its two highest priority items. A computational fluid dynamic modeling (CFD) center was established at University of

Minnesota. The center will be a cooperative venture between the Coleraine Minerals Research Laboratory and the Department of Chemical Engineering at UMD. A concentrator modeling center will also be established. A committee is meeting to develop the business plan and select a site for the concentrator modeling center.

The CFD center's efforts are expected to focus on improving pelletizing operations at the State's taconite plants. An employee from the Department of Chemical Engineering has written a one-dimensional model that estimates heat and mass transfer, pellet drying and oxidation, and nitric oxide emissions on Grate-kiln pelletizing machines. The model has been calibrated on several pelletizing lines using existing data and the results have justified the expenditure for additional mass flow instrumentation on one of the lines at Minntac.

The 1997 Minnesota Legislature created two new financial incentives for the mining industry. Grant funding of \$3.5 million was appropriated for the development of a direct reduction iron processing facility in Minnesota. A technology grant program was also created for the taconite industry for research work that would reduce energy consumption, reduce environmental emissions, improve productivity, or improve pellet quality. The initial grant funding of \$650,000 was awarded to National Steel Pellet Co. for modification to its pelletizing line.

Legislation was passed to clarify the ownership of stockpiled metallic minerals material surrounding many of the former mining sites in the State. Tax forfeitures of real estate containing stockpiles were creating ownership issues that affected local landuse management decisionmaking. The legislation was introduced after study and discussion by representatives of State and local government, fee and stockpile owners, and mining industry representatives.

Research on the use of several biosolids as a soil amendment for revegetation of coarse tailings was initiated at EVTAC Mining Co. and National Steel Pellet Co. Biosolids being evaluated include dredge spoils, paper manufacturing wastes, sewage sludge, and composted municipal solid waste.

According to USGS preliminary estimates (*table 1*), about 59 million tons of aggregate valued at \$221 million was produced in 1997. Aggregate consumption continues to rise in Minnesota. Consumption falls into four general categories: roads; public works projects; residential construction; and commercial/industrial applications. According to the Minnesota Department of Transportation (MDOT), total government investment in the State's transportation infrastructure will be approximately \$2.2 billion for the 3-year period 1997-99. The Department of Natural Resources (DNR) works with MDOT and local governments to identify new potential areas of aggregate resources to meet future road construction project needs.

In June 1997, the Clay County Beach Ridges Forum concluded a 2-year discussion by landowners, aggregate producers, supporters of native prairie, interested public, and government agencies about gravel mining and prairie protection. The forum developed computerized resource information on CD-ROM, a coloring book for children showing the value of prairie and gravel resources, a handbook of one-page fact sheets, maps, and a final report containing recommendations.

Minnesota is making a number of efforts to educate K-12 teachers about exploration and mining-related issues. A collaborative effort by industry, government, and academia led to the first annual Minnesota Minerals Education Workshop in August 1997. The 3-day workshop included speakers, hands-on classroom activities, resource materials, and field trips to geological formations and mining operations.

To improve and expand communication with Mesabi Range land management groups, the DNR developed Geographic Information System maps which illustrated existing minerals information in a user-friendly format. Efforts began in 1997 to present this information to communities to aid in the initial steps of land use planning. Communities, governments, and the mining industry can use customized pertinent data to utilize existing minerals resources and to plan for future land use after mining is completed.

TABLE 1  
MINNESOTA: NONFUEL RAW MINERAL PRODUCTION 1/ 2/

(Thousand metric tons and thousand dollars unless otherwise specified)

Mineral	1995		1996		1997 p/	
	Quantity	Value	Quantity	Value	Quantity	Value
<b>Clays:</b>						
Common	27	W	11	W	W	W
Kaolin	21	W	--	--	--	--
Gemstones	NA	26	NA	148	NA	677
Iron ore, usable	47,000	1,330,000	46,700	1,330,000	46,900	1,330,000
Peat	24	2,070	20	1,540	37	2,610
Sand and gravel, construction	31,900	99,400	31,800	107,000	46,800	161,000
<b>Stone:</b>						
Crushed	11,300 3/	47,400 3/	12,100	59,000	12,000	60,000
Dimension	metric tons	26,900	11,100	25,400	10,700	25,600
Combined value of lime, sand and gravel (industrial), stone [crushed quartzite and traprock (1995)], and values indicated by symbol W	XX	40,400	XX	35,100	XX	34,900
<b>Total</b>	XX	1,530,000	XX	1,540,000	XX	1,600,000

p/ Preliminary. NA Not available. W Withheld to avoid disclosing company proprietary data; value included with "Combined value" data. XX Not applicable.

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

2/ Data are rounded to three significant digits; may not add to totals shown.

3/ Excludes certain stones; kind and value included with "Combined value" data.

TABLE 2  
MINNESOTA: CRUSHED STONE SOLD OR USED, BY KIND 1/

Kind	1995 2/				1996			
	Number of quarries	Quantity (thousand metric tons)	Value (thousands)	Unit value	Number of quarries	Quantity (thousand metric tons)	Value (thousands)	Unit value
Limestone	29 r/	7,490 r/	\$32,400 r/	\$4.33	43	8,210	\$38,800	\$4.73
Granite	6 r/	W	W	4.63	4	W	W	W
Dolomite	5	W	2,420	W	3	802	3,480	4.34
Sandstone and quartzite	6 r/	W	W	4.27	6	944	W	W
Traprock	--	--	--	--	1	W	W	4.39
<b>Total</b>	XX	11,300	47,400	4.19	XX	12,100	59,000	4.88

r/ Revised. W Withheld to avoid disclosing company proprietary data; included in "Total." XX Not applicable.

1/ Data are rounded to three significant digits; may not add to totals shown.

2/ Excludes quartzite and traprock from State total to avoid disclosing company proprietary data.

TABLE 3  
MINNESOTA: CRUSHED STONE SOLD OR USED BY PRODUCERS IN 1996,  
BY USE 1/ 2/ 3/

Use	Quantity (thousand metric tons)	Value (thousands)	Unit value
<b>Coarse aggregate (+1 1/2 inch):</b>			
Riprap and jetty stone	231	\$1,690	\$7.33
Filter stone	191	1,150	6.02
<b>Coarse aggregate, graded:</b>			
Concrete aggregate, coarse	849	5,770	6.79
Bituminous aggregate, coarse	312	1,740	5.58
Railroad ballast	839	5,550	6.62
Other graded coarse aggregate 4/	68	600	8.82
<b>Fine aggregate (-3/8 inch)</b>			
Stone sand, concrete	53	280	5.28
Stone sand, bituminous mix or seal	99	338	3.41
Other fine aggregate 5/	226	1,120	4.95
<b>Coarse and fine aggregates:</b>			
Graded road base or subbase	2,500	11,400	4.55
Unpaved road surfacing	530	1,820	3.43
Terrazzo and exposed aggregate	W	W	9.74
Crusher run or fill or waste	W	W	2.28
Other coarse and fine aggregates	W	W	4.75
Other construction materials	280	1,720	6.16
<b>Agricultural:</b>			
Agricultural limestone	199	1,070	5.39
Poultry grit and mineral food	(6/)	(6/)	15.57
Chemical and metallurgical: Lime manufacture	(6/)	(6/)	7.25
<b>Unspecified: 7/</b>			
Actual	2,440	10,700	4.38
Estimated	3,270	14,000	4.28
Total	12,100	59,000	4.88

W Withheld to avoid disclosing company proprietary data; included with "Other construction materials."

1/ To avoid disclosing company proprietary data; district tables were not produced for 1996.

2/ Includes dolomite, granite, limestone, sandstone, quartzite, and traprock.

3/ Data are rounded to three significant digits; may not add to totals shown.

4/ Includes bituminous surface-treatment aggregate.

5/ Includes screening (undesignated).

6/ Withheld to avoid disclosing company proprietary data; included in "Total."

7/ Includes production reported without a breakdown by end use and with estimates for nonrespondents.

TABLE 4  
MINNESOTA: CONSTRUCTION SAND AND GRAVEL SOLD OR USED IN 1996,  
BY MAJOR USE CATEGORY 1/

Use	Quantity (thousand metric tons)	Value (thousands)	Value per ton
Concrete aggregate (including concrete sand)	7,680	\$35,400	\$4.61
Plaster and gunite sands	89	710	7.98
Concrete products (blocks, bricks, pipe, decorative, etc.)	221	1,780	8.05
Asphaltic concrete aggregates and other bituminous mixtures	2,850	11,700	4.12
Road base and coverings 2/	9,410	21,800	2.32
Fill	2,220	3,920	1.77
Snow and ice control	238	816	3.43
Railroad ballast	299	709	2.37
Other miscellaneous uses 3/	281	888	3.16
Unspecified: 4/			
Actual	2,050	9,760	4.75
Estimated	6,510	19,600	3.00
Total or average	31,800	107,000	3.36

1/ Data are rounded to three significant digits; may not add to totals shown.

2/ Includes road and other stabilization (cement and lime).

3/ Includes filtration and roofing granules.

4/ Includes production reported without a breakdown by end use and with estimates for nonrespondents.

TABLE 5  
MINNESOTA: CONSTRUCTION SAND AND GRAVEL SOLD OR USED IN 1996, BY USE AND DISTRICT 1/

(Thousand metric tons and thousand dollars)

Use	District 1		District 2		District 3	
	Quantity	Value	Quantity	Value	Quantity	Value
Concrete aggregate and concrete products 2/	440	2,600	359	1,900	1,640	6,020
Asphaltic concrete aggregates and road base materials 3/	1,860	4,050	880	2,040	5,900	12,400
Snow and ice control	26	85	55	130	86	222
Other miscellaneous uses 4/	174	437	282	682	44	229
Unspecified: 5/						
Actual	438	2,260	322	762	179	2,900
Estimated	1,810	5,120	754	2,300	880	2,530
Total	4,740	14,600	2,650	7,820	8,730	24,300
Use	District 4		District 5		District 6	
	Quantity	Value	Quantity	Value	Quantity	Value
Concrete aggregate and concrete products 2/	627	3,150	4,500	21,900	425	2,250
Asphaltic concrete aggregates and road base materials 3/	1,950	7,150	2,500	8,700	1,390	3,150
Snow and ice control	19	58	26	234	26	86
Other miscellaneous uses 4/	22	114	19	43	38	93
Unspecified: 5/						
Actual	344	1,100	542	2,070	228	661
Estimated	1,200	3,870	1,190	3,240	677	2,500
Total	4,160	15,400	8,770	36,200	2,780	8,750

1/ Data are rounded to three significant digits; may not add to totals shown.

2/ Includes plaster and gunite sands.

3/ Includes fill and road and other stabilization (cement and lime).

4/ Includes filtration, railroad ballast and roofing granules.

5/ Includes production reported without a breakdown by end use and with estimates for nonrespondents.