MINNESOTA MINERAL DIVERSIFICATION

BIENNIAL FUNDING PLAN AND STATUS REPORT (F.Y. 90-91)

JANUARY 1989

MINNESOTA MINERALS COORDINATING COMMITTEE

MDNR MGS MRRC NRRI

MINNESOTA MINERAL DIVERSIFICATION

BIENNIAL FUNDING PLAN AND STATUS REPORT

(F.Y. 90-91)

Prepared By

MINNESOTA MINERALS COORDINATING COMMITTEE

January, 1989

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EXECUTIVE SUMMARY

This is the first biennial funding plan for mineral diversification. It was prepared by the Minnesota Minerals Coordinating Committee for the Legislature pursuant to Minnesota Statutes, Sections 93.001-002, which are devoted to diversification of Minesota's mineral resources.

This biennial plan presents the Committee's recommendations for FY90-91 funding within the framework of Minnesota Mineral Diversification, Ten Year Plan, presented to the Legislature in January, 1988.

The Minnesota Minerals Coordinating Committee recommends continued support for successful, on-going projects, and additional funding for proposals that will further enhance mineral diversification.

Diversification projects in FY88-89 were highly successful in extending Minnesota's potential for an expanded and diversified mineral economy. Especially productive projects in the iron ore project area were those that focused on quality improvements for taconite pellets and process technology advances. Industrial adoption of these new technologies has led to a more competitive product.

In the non-ferrous project area, significant progress was made in compiling new geologic information that will encourage private mineral exploration efforts. One project in particular, which identified precious metals traces in glacial overburden, attracted strong competitive bidding for non-ferrous metallic minerals leases in the area of investigation.

The industrial minerals project area also had important advances. Among them are the resource inventory projects, which identified new potential clay, sand, and gravel; and processing research, which has provided public technical data verifying that paper quality kaolin can be produced from Minnesota River Valley clay resources.

This Biennial Funding Plan is the product of a year-long process, which included wide interagency involvement, opportunities for industry input, and careful prioritization of projects. It reflects the best judgment of the members of the Minerals Coordinating Committee concerning the issues and factors outlined, priorities, and strategies the state should implement to encourage further diversification of its mineral resources.

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INTRODUCTION

This funding priority plan is a direct outgrowth of the planning process initiated by the Legislature to promote diversification of Minnesota's mineral resources (Minn. Stat. Secs. 93.001-002).

In 1987, the Legislature formalized the Minnesota Minerals Coordinating Committee, which includes the directors of the Minerals Division of the Department of Natural Resources, the Minnesota Geological Survey, the Mineral Resources Research Center, and the Natural Resources Research Institute. The Committee members were charged with preparing a ten-year plan for diversifying Minnesota's mineral industries. The Legislature also directed the Committee to develop two-year funding priority plans to be updated biennially.

The Ten-Year Plan, submitted to the Legislature in January, 1988, provides the framework for mineral diversification in the long run. It includes objectives for three main commodity areas, plus basic research. The commodity areas and objectives are:

- **Ferrous Minerals: To improve and extend the iron ore industry.** To make the iron ore/taconite industries more competitive through improved process efficiencies and adoption of product value-added technologies.
- **Non-ferrous Minerals: To encourage exploration and development of non-ferrous metallic minerals.** To attract new, environmentally sound, exploration and development through new geologic information, environmental research and planning, and increased land availability.
- **Industrial Minerals: To enhance Minnesota's industrial minerals industry.** To enhance and expand the state's industrial minerals base through resource assessment and market and product development.
- **Basic research:** To lay the research foundation for later work to stimulate Minnesota's mineral economy.

The Minerals Coordinating Committee must balance a number of factors in recommending funding priorities. One factor is the necessarily long-term nature of mineral diversification. Establishing the geologic information base, technological research foundations, and business and regulatory climate to encourage diversification requires an extended commitment by all involved.

Another factor is the nature and adequacy of environmental management of new mineral development. To both maintain Minnesota's high standards for environmental quality and accommodate industry's need to act quickly on a mineral discovery, it is essential that environmental and regulatory issues be clearly resolved, to the greatest extent possible, in advance of development proposals.

Diversification's basic research requirement is a third factor. Without its underpinnings for generating ideas, needed insight on regional geology, mineral characterization, and specific mineral processing technologies may not be available to support future development.

The Minerals Coordinating Committee has actively sought advice and counsel from the private sector concerning project and funding priorities. Shortly after presenting the Ten Year Plan to the Legislature, the Committee created working advisory committees in each of the three commodity areas addressed in the Plan: ferrous, non-ferrous, and industrial minerals. The Advisory Committees advise the Minerals Coordinating Committee on selection of worthwhile minerals projects, provide informed feedback on the progress of projects underway, and communicate industry concerns about minerals policy and planning.

The Natural Resources Research Institute (NRRI) has been designated the research institute for natural resources for the Greater Minnesota Corporation. Through NRRI, the Minerals Coordinating Committee will work with the Greater Minnesota Corporation to ensure coordination and review of minerals funding proposals.

This biennial funding priority plan reflects the best judgment of the members of the Minerals Coordinating Committee concerning the issues and factors outlined, and is a direct outgrowth of the process described in the Minnesota Mineral Diversification Ten Year Plan.

EXPLANATION OF FUNDING REQUEST

The three objective areas, basic research, and the FY90-91 funding requested for each, are detailed in the table on page 3.

Funding is requested from a number of sources. Core diversification funding requests are included in the BASE level request of the Department of Natural Resources (DNR-B, $1,734.0); the Department's CHANGE level request (DNR-C, $1,000.0); and the additional funding request of the Minerals Coordinating Committee (MCC-C, $4,100.0). Past funding for Mineral Diversification has been appropriated through the Department of Natural Resources.

Additional funding for diversification projects is anticipated through the Minnesota Future Resources Commission; the Iron Ore Cooperative Research Program; the Iron Range Resources and Rehabilitation Board, and the American Iron and Steel Institute. The Committee also supports the request of the Minnesota Department of Trade and Economic Development ($87.5) for a Mineral Industry Specialist.

The Greater Minnesota Corporation represents an additional source of funding for minerals research through its relationship with NRRI. It is planned to coordinate

proposal development, evaluation, and project selection through the Coordinating Committee.

Funding needs total $9,535.5, which is consistent with the level recommended in the Ten-Year Plan. Of this amount, $5.1 million (DNR-C plus MCC-C), represents new funding. Also reflecting Ten Year Plan recommendations, the funds would be allocated as follows: approximately 30 percent to ferrous minerals projects, 46 percent to non-ferrous minerals projects, 16 percent to industrial minerals projects and 8 percent to basic research.

MINERAL DIVERSIFICATION PROGRAM
Biennial Funding Plan FY 90 - 91 (in 1,000s)

Funding Sources	MFRC(a)	DIVERSIFICATION			COOP(e)	OTHER	TOTAL
		DNR-B(b)	DNR-C(c)	MCC-C(d)			
Objectives							
Ferrous	$200.0	$200.0	$200.0	$1,270.0	$614.0	$660.0(f)	$3,144.0
Non-ferrous	$1,010.0	$890.0	$410.0	$1,740.0		$87.5(g)	$4,137.5
Industrial Minerals	$130.0	$464.0	$290.0	$650.0			$1,534.0
Basic Research		$180.0	$100.0	$440.0			$720.0
TOTAL	$1,340.0	$1,734.0	$1,000.0	$4,100.0	$614.0	$747.5	$9,535.5

(a) Minnesota Future Resources Commission

(b) DNR BASE level request includes $1.0 million from the minerals portion of the Rural Development Act, $244.0 from Industrial Mineral Development funding in the DNR Minerals Division budget, and $490.0 estimated receipts for the DNR Lease and Exploration Account. The Lease and Exploration Account is a revolving account from general fund receipts from mineral leases.

(c) DNR Mineral Diversification CHANGE level request

(d) Mineral Coordinating Committee Diversification CHANGE request

(e) Iron Ore Cooperative Research

(f) IRRRB and AISI (American Iron and Steel Institute)($260.0) and one-to-one industry match required for COOP (first $400.0)

(g) Dept. of Trade and Economic Development Industry Specialist

OBJECTIVE AREAS, STATUS, PRIORITIES & PROJECT PROPOSALS

OBJECTIVE 1 - To Improve & Extend the Iron Ore Industry

Current Status

The iron mining industry has rebounded from previous low production due to strong domestic demand for steel. During the low period the industry improved productivity, introduced new technology to reduce costs, and improved the competitiveness of Minnesota taconite. Pellet production costs have been reduced to a level that is now strongly competitive with off-shore supplies. Recent reports indicate that Minnesota pellet production was about 40 million short tons in 1988. At least two companies have or will be restarting additional pelletizing lines, and at least two additional companies are considering making bids for the Reserve taconite facility. This could lead to its reopening soon. Most plants are at near-maximum capacity and the demand for Minnesota pellets looks strong for 1989.

However, the industry's links to the domestic steel industry make it extremely vulnerable to short term changes in the value of the dollar, import restrictions and, in the long run, the condition of customer steel plants. The challenge is to keep Minnesota taconite pellets at a competitive cost and at a premium quality level so that if there is a decrease in market demand for iron, Minnesota pellets will preferentially retain their market position.

FY88-89 Accomplishments

Significant progress in:

- assessment of improved mining and crushing methods;
- pellet production process control technology and methods;
- production of lower silica fluxed pellets in two plants;
- improvement of pellet high temperature properties;
- evaluation of opportunities for added value products in Minnesota, such as pig iron and steel slabs;
- basic research objectives, such as automated metallurgical analysis; and
- adoption of organic binders to replace bentonite.

The critical effect of pellet quality on blast furnace performance is becoming increasingly apparent. Pellet properties are now being modified to achieve lower coke rates and higher throughputs, with significant impacts on blast furnace costs. Achievement of finer crushing, while still in the experimental stage, should lead to significantly reduced costs if the initial results can be duplicated by in-plant tests.

FY90-91 Priorities, Goals, and Strategies

Maintaining a strong competitive position for Minnesota pellets both in terms of costs and quality remains a top priority. Industry has demonstrated that blast furnace performance can be improved by using fluxed pellets. Cooperative research efforts will continue further development of low silica fluxed pellets, metallurgical improvement of acid pellets, and processing changes to reduce pellet production costs.

The overriding goals of the ferrous metals portion of the Minerals Diversification Program are: 1) to improve the quality of Minnesota pellets as a blast furnace feed stock; and 2) to ensure that changes in iron or steel making technology improve the market for Minnesota pellets.

The strategies to accomplish these goals relate to long-term funding of research on Minnesota's magnetite resource. The specific priorities for the next biennium are:

- Improving the quality of fluxed pellets through improved firing process controls;

- Decreasing the cost to produce fluxed pellets through improvements in flux grinding systems and improved filter operations;
- Developing means to economically reduce the silica level in Minnesota pellets;
- Decreasing crushing and concentrating costs by improved primary fragmentation in the mine; and
- Improving process control systems for both concentration and agglomeration.

Work on iron ore is conducted through the Iron Ore Cooperative Research program and the ferrous minerals portion of the Mineral Diversification Program. The Cooperative Research Program focuses on shorter-term research that can be implemented quickly. The state's funds are matched with industry funds, and project selection is driven by the needs of the iron mining industry. The Diversification Program focuses on longer-term research where large returns are possible, but may be a few years in the future. The Ferrous Minerals Advisory Committee helps the Minerals Coordinating Committee prioritize projects, and industry matching funds are not required.

The distinction between short-term and long-term is somewhat arbitrary, and results of the advisory committee meetings indicate that industry has many shorter-term research needs that cannot be covered by the limited funding in the Cooperative Research Program. The Committee has blended short and long-term needs to achieve a balanced iron ore research program within Mineral Diversification.

Proposed Projects to Improve and Extend Minnesota's Iron Industry

Product Quality:

- Improved fluxed pellets (Phases 2 & 3). This project seeks to continue progress in cost reduction of fluxed pellets through the use of Minnesota lime/dolomite to produce lime/dolomite hydrate. (DNR-B,DNR-C)*
  *Note: Initials in parentheses indicate funding sources detailed in Appendix 1.
- Super concentrates. To achieve very low silica levels in taconite concentrate. One percent silica is the goal. (MFRC, IRRRB, AISI)
- Control systems improvement. To improve measurement and feedback systems to reduce product variability. (MCC-C)
- Development of digital image interpretation unit. Quantify size distribution dynamically using digital devices to improve crushing, grinding, and agglomeration. (US Bureau of Mines)
- Improved pellets through control of process temperatures. To quantify the effects of water temperature on grinding, classification, and filtration, and

study the effects of temperature profile on the grate during firing. (DNR-B,MCC-C)

Process Technology:

- Froth flotation to reduce grinding cost. To remove high silica particles selectively for regrinding and subsequent separation. (MCC-C)
- Improved primary fragmentation. To quantify the positive effects of better fragmentation on downstream crushing and grinding. (DNR-C, MCC-C)
- Improved size classification. To increase the efficiency of fine grinding mills by reducing the recirculation of fine particles, i.e., reduced overgrinding and production of excessive fines. (MCC-C)
- Innovative comminution techniques. To test new methods of crushing and grinding for applicability to taconite processing. (MCC-C)

Value-added:

- Value-added technology evaluations. To maintain up-to-date cost estimates and material and energy balances in iron and/or new steel-making technologies that might be used in Minnesota. (MCC-C)

Iron Ore Cooperative Research:

The cooperative research areas identified as high priority in the next biennium are:

- Rod mill/ball mill conversion. In-plant tests will be run in the next biennium, if the results of the pilot scale tests currently being conducted point to successful conversion. (COOP, other)
- Grate casting deterioration. Those plants that have converted to fluxed pellet production are noticing accelerated deterioration and necessary replacement of grate bars. A study will be conducted to determine the cause of this problem and to suggest mitigative measures. (COOP, other)
- Acid pellet high temperature property improvement. Past work in this area showed several possible ways to improve pellet properties, e.g., lower silica or better size control. These will be evaluated further in larger scale tests. (COOP, other)
- Lasentec Particle Size Analyzer/grind-filtering application. The second phase of this work will consist of in-plant tests of the device, if the laboratory tests are successful. (COOP, other)
- Oxygen enrichment. The next phase of this work will be pilot scale tests in a small kiln modified with oxygen or air inlet ports. (COOP, other)

- Coarse cobbing of lean ore. In-pit magnetic separation tests will be run on minus 6-inch feed to determine if a portion of the lean ore that is now sent to stockpiles can instead be sent to the plant for processing. (COOP, other)

OBJECTIVE 2 - To Encourage Exploration and Development of Non-ferrous Metallic Minerals

Current Status

Minnesota is in global competition to attract exploration expenditures and mineral development. Pursuit of new mineral resources usually occurs in areas with, among other things, the highest probability for discovery. Geologists have believed for many years that Minnesota has high potential for developing non-ferrous metals (e.g., gold, platinum group minerals, titanium, copper, etc.). However, mineral exploration in most of Minnesota has been hindered by lack of detailed knowledge of the bedrock geology, particularly in areas with few outcrops and a thick cover of glacially deposited sand, silt, and gravel.

To attract exploration and development, Minnesota must develop geologic and mineral potential data and provide the administrative and economic climate that makes development predictable and attractive, while assuring environmental protection. This translates directly to a program that encompasses geologic mapping and mineral potential evaluation, as well as leasing and technical information programs.

Exploration interest and activity in Minnesota continue to climb. This is due in part to the efforts of the Minerals Coordinating Committee member agencies to develop geologic and mineral potential information, and make it readily available. With the awarding of leases bid on at the September, 1988, mineral lease sale, 32 companies will be exploring for non-ferrous minerals in Minnesota. These companies range from Minnesota-based to national to international and vary greatly in size. Following award of leases in early 1989, exploration companies will have about 240,000 acres of state minerals under lease, through 619 separate leases in 10 counties. Significant amounts of private and federal mineral rights are under lease in addition to state-owned mineral rights. Exploration is focused primarily on metals such as gold, silver, platinum and palladium. No non-ferrous developments have been proposed to-date, however, high levels of exploration are continuing.

FY88-89 Accomplishments

Significant Progress in:

- drilling and bedrock mapping of key mineral potential areas;
- the Minnesota aeromagnetic survey, funded by the Minnesota Future Resources Commission, which provides critical data about buried bedrock, useful to mineral explorers;

- glacial drift (overburden) drilling and geochemistry, which stimulated highly competitive bidding in the September, 1988 lease sale;
- sampling the basal zone of the Duluth Complex for platinum group elements;
- sampling and analysis of greenstone drill core (housed in the Hibbing drill core library), which has uncovered some promisingly high mineral values;
- consideration of ore deposit models for gold and platinum group elements in Minnesota;
- non-ferrous metallic minerals environmental research and mine permitting simulation;
- economic evaluation of non-ferrous mining ventures;
- distribution of information about Minnesota's mineral potential;
- evaluating regional mineral potential through regional geochemistry projects, such as the lithogeochemistry project in the Duluth complex;
- mineral lease rules that simplify leasing state minerals and modify royalty rates;
- land availability for mineral leasing;
- process technology research for Minnesota's ilmenite (titanium ore) resources; and
- basic non-ferrous minerals research.

FY90-91 Priorities, Goals, and Strategies

A coordinated approach to developing geologic and mineral potential data will continue with expanded emphasis placed on producing geologic maps of previously unmapped areas, and regional mineral evaluations such as geochemical surveys and analysis of existing bedrock drill core.

Increased industry interest in leasing and exploring state lands has been the basis for placing high priority on accelerated mineral leasing, which will make state mineral rights more frequently and easily available to industry. This acceleration will consist of more frequent mineral lease sales and a quickening of severed mineral ownership identification. The goal of these activities is to make state land available for exploration on a timely basis while insuring an equitable return to the state.

As exploration advances toward development proposals, research in two additional areas will become increasingly important: environmental research to ensure sound development and reclamation of mined lands; and mineral processing research to effectively employ new technologies.

Proposed Projects to Encourage Exploration and Development of Non-ferrous Metallic Minerals

Aeromagnetic survey:

- This is the completion of the statewide aeromagnetic survey that is so critical for creating information about deeply buried bedrock for the mineral exploration industry. (MFRC)

Geologic mapping and drilling (Itasca County map & geochronology; Cook area map):

- Accelerated geologic drilling and mapping. Drill holes supply the most concrete evidence of bedrock for accurate mapping purposes in drift covered areas. The maps produced are important guides to Minnesota's mineral potential and stimulate exploration. (DNR-B, DNR-C, MCC-C)

Geochemistry:

- Geochemical relationships between platinum group elements and iron titanium deposits in the Partridge River area. This study is directed toward compiling geochemical data on the host rocks of the area in order to describe the mineral occurrence values of different rock types as an aid to exploration. (MCC-C)
- Glacial till geochemistry. The continuance of a highly successful project to identify regional scale dispersal of gold and other metals in glacial overburden. (DNR-B,DNR-C, MCC-C)
- Bedrock geochemistry. Helps establish the mineral potential values of different greenstone bedrock types. (DNR-B, MCC-C)
- Airborne spectral radiometry. To investigate the use of remote sensing of heavy metal stresses in plants, which in turn may serve as indicators of ore deposits buried beneath glacial overburden. (MFRC)

Non-Ferrous Minerals Processing:

- Ilmenite processing. Continues work to develop methods for cost-effective processing of Minnesota ilmenite (titanium ore). (MCC-C)
- Platinum group element mineralogy identification with QEM-SEM. To investigate a potential exploration tool for both bedrock and glacial till. The QEM-SEM technique may also prove useful for understanding the relationship between bulk mineralogy and precious metals occurrences. (MCC-C)

Data Acquisition and Analysis:

- Drill core examination and assay. Analyses will focus on base and precious metal mineralization, and associated alteration. (DNR-B, MCC-C)
- Minerals data base. A minerals data base is crucial for disseminating information on Minnesota's minerals to the public, private exploration and mining

companies, and state and local government. The data base will identify information available at cooperating agencies and lead, ultimately, to a unified interagency database system. (DNR-B, DNR-C, MCC-B)

- Acquisition of private exploration data. To make available previously inaccessible private geologic and mineral potential data to encourage exploration. (MFRC)
- Mineral deposit models seminar. The proposed 1990 workshop will consider possible mineral targets that are not yet the subject of commercial interest in Minnesota. (DNR-B)
- Graphite with precious metals. An investigation into graphite occurrences in east central Minnesota with emphasis on secondary precious metals. (MCC-C)

Environmental Research:

- Non-ferrous reclamation research. To seek solutions to the environmental issues - mining, water and waste management, and mineral processing - that will be associated with new mining in Minnesota. (DNR-B, DNR-C, MCC-C)

Economic Development Assistance:

- Minerals Industry Specialist. To provide staff in the Department of Trade and Economic Development to support new mineral development ventures. (T&ED)

Proposed Accelerated Mineral Leasing:

- Accelerated leasing. Will provide an increase in lease sale frequency to two yearly, oil and gas lease rules, high value industrial minerals leasing rules, and investigation of alternative leasing methods. (DNR-C, MCC-C)
- Improved ownership records - St. Louis County. The state's largest county has high mineral potential but lacks a comprehensive and accessible land ownership record, which is vital to expanded leasing and exploration. (MFRC)
- Severed mineral identification. Much of the state's severed mineral interests are insufficiently documented. This project seeks to identify severed mineral ownership and lease the state minerals identified. (DNR-B, DNR-C, MCC-C)

OBJECTIVE 3 - To Enhance Minnesota's Industrial Minerals Industry

Current Status

Minnesota's industrial minerals industry produces commodities valued at over $135 million annually. Currently, there are 3 active kaolin pits in the Brown County-Redwood County area producing kaolin for the cement, brick, and tile industries. There

are over 460 sand and gravel companies, 3 industrial sand operations, 56 aggregate operations (3 basalt, 6 granite, 46 limestone and 1 quartzite) and 8 dimension stone companies (4 granite, 1 quartzite and 3 limestone). Considerable interest in paper grades of kaolin is being demonstrated by several companies through their leasing programs in the Redwood Falls/Fairfax area. When including indirect and secondary benefits, this industry is vital to the State's regional and overall economy.

Although a mature and stable industry now exists, considerable effort is being made by private firms to expand production, broaden markets, and acquire a larger resource position. Examples include: the opening of new clay pits in central and western Minnesota and substantial exploratory drilling by the private sector for high-grade kaolin deposits; the strong dimension stone market, spurred by a revival in the architectural use of dimension stone, that has led to a demand for additional stone resources; projections for increased aggregate demand in urban areas; and, recent investments in the horticultural peat industry by Canadian firms.

FY88-89 Accomplishments

Significant progress in:

- assessment of southeast Minnesota's carbonate rock resources, which may have potential for lime production, taconite pellet flux, and other products;
- regional evaluation of Minnesota clay resources;
- first public information confirming the technical ability to produce paper grade kaolin products from Minnesota kaolin resources;
- identification of environmental aspects of potential kaolin development in the Minnesota River Valley area;
- promotion and sales of horticultural peat through: industry organizational efforts by the Minnesota Peat Association, creation of a Minnesota horticultural peat logo, and national trade show representation. These accomplishments will help Minnesota become more competitive in domestic and Canadian markets;
- sand and gravel resource inventory of Wright County completed as part of a statewide program for county planning and zoning use; and
- completed statewide inventory of industrial mineral commodities.

FY90-91 Priorities, Goals, and Strategies

Enhanced development of the state's industrial mineral resources will be furthered through efforts to:

- strengthen existing industries through additional geological and resource assessment programs, e.g., clays, silica, and dimension stone;

- provide an economic assessment of the current state of industrial minerals in Minnesota;
- evaluate possible industrial mineral leasing and reclamation rules;
- conduct research to determine to what product/market categories Minnesota's industrial minerals apply, to guide product development; and
- conduct research to develop products and processes that will enhance the utilization of Minnesota's clay resources.

Proposed Projects to Enhance Minnesota's Industrial Minerals Industry

Aggregate studies:

- Sand/gravel county inventory. Detailed inventory work to document important deposits in each county. (DNR-B, DNR-C)
- Sand/gravel restoration practices. Preliminary investigation into the need in Minnesota and methods for sand and gravel mining restoration. (MCC-C)

High-value industrial mineral surveys and marketing

- Cement raw materials and products. Minnesota imports cement when it may be possible to make it from local resources. This investigation will determine if a combination of process technology and product potential can be found that would serve as a basis for a local cement industry. (DNR-C, MCC-C)
- Carbonate resources regional assessment. An investigation of limestone and dolomite rock resources, mostly in Minnesota's southeast quadrant. (DNR-B)
- Regional surveys and process and product development investigations for Minnesota clay. (DNR-B, DNR-C, MCC-C)
- Dimension stone expansion. An assessment of new areas of dimension stone resources in Minnesota. (DNR-BIM)
- Competitive markets for industrial minerals. A study designed to match Minnesota industrial minerals with existing markets where they might be competitive with current suppliers. (MCC-C)

- Peat marketing. Continuing the effort to make Minnesota horticultural peat competitive in domestic and Canadian markets by enhancing name recognition, developing quality standards, and creating marketing cooperation among Minnesota producers. (DNR-BIM)
- Peat development environmental monitoring. To evaluate two horticultural-quality peat bogs, one in St. Louis County and one in Koochiching County, for development feasibility. (DNR-BIM)
- Silica resource assessment. To survey areas with potential for the production of quality industrial (silica) sands. (MCC-C)

Waste Product Utilization

- Peat product development (poultry project). To assess and design a system for poultry waste/runoff control using peat litter and to pursue the potential for production of peat-based fertilizer from the litter. (MFRC)
- Synthetic aggregates from industrial waste. Ash and other industrial wastes may have potential for incorporation into synthetic aggregates. This project will investigate the potential. (MCC-C)

BASIC RESEARCH

In recognition of the importance of basic research to mineral diversification, the Minerals Coordinating Committee delegated to the University of Minnesota a basic research project review and funding mechanism. A portion of Legislative Diversification funding is allocated to the University's Earth Resources Subcommittee, an arm of the University Council for Natural Resources. The subcommittee solicits proposals for minerals basic research from both the University and other Minnesota academic institutions. Submitted proposals are given peer review and forwarded to the Coordinating Committee for final approval.

APPENDICES

MINERALS COORDINATING COMMITTEE
MINERAL DIVERSIFICATION
Last Revision: 1/12/89

APPENDIX 1 - Comprehensive Diversification Summary Spreadsheet

Appropriation/Project	FY 88	FY 89	FY 90	Source	FY 91	Source	Project Manager
PROPOSED FERROUS PROJECTS:							
Product Quality:							
Improved fluxed pellets (Phases 2 & 3)			$50.0	DNR-B	$50.0	DNR-B	NRRI
			$50.0	DNR-C	$50.0	DNR-C	
Super concentrates			$100.0	MFRC	$100.0	MFRC	NRRI/MRRC
			$25.0	IRRRB	$25.0	IRRRB	
			$110.0	AISI	$100.0	AISI	
Control systems improvement			$75.0	MCC-C	$75.0	MCC-C	MRRC
Development of Digital Image Interpretation Unit		$15.0					USBM
Improved pellets through control of process temperatures.			$50.0	DNR-B	$50.0	DNR-B	NRRI
			$100.0	MCC-C	$100.0	MCC-C	
Process Technology:							
Froth flotation to reduce grinding cost			$100.0	MCC-C	$100.0	MCC-C	NRRI
Improving primary fragmentation			$50.0	DNR-C	$50.0	DNR-C	NRRI
			$145.0	MCC-C	$145.0	MCC-C	
Improved size classification			$100.0	MCC-C	$100.0	MCC-C	NRRI
Innovative comminution techniques			$75.0	MCC-C	$75.0	MCC-C	MRRC
Value Added:							
Value-added technology evaluations			$40.0	MCC-C	$40.0	MCC-C	DNR
COREX	$27.7						
Iron Ore Cooperative Research:			$307.0 *	COOP	$307.0 *	COOP	DNR
Rod Mill/Ball Mill Conversion Project	$50.0	$18.2					NRRI
Water Chemistry Impacts on Taconite Production	$61.1						M.A. HANNA
High Temperature Properties of Acid Pellets	$40.0	$47.0					PM
Slagging Combustor Evaluation	$47.0						MRRC
Moisture Meter Review	$7.0						MRRC
Evaluation of PAR-TEC 200 Particle Size Analyzer		$35.0					MRRC
Fluxed Pellet Filtration Study		$24.0					NRRI
Secondary Grinding Study		$62.0					M.A. HANNA
Low Silica Concentrates Project		$79.0					NRRI
Oxygen Enrichment Study		$61.0					PM

Funding by Source:		
DNR-B (Dept of Nat'l Resources BASE level request)	$100.0	$100.0
DNR-C (Dept of Nat'l Resources CHANGE level request)	$100.0	$100.0
COOP (Iron Ore Cooperative Research)	$307.0	$307.0
MCC-C (Coordinating Committee Diversification CHANGE Request)	$635.0	$635.0
MFRC (Minnesota Future Resources Commission)	$100.0	$100.0
IRRRB (Iron Range Resources Rehabilitation Board)	$25.0	$25.0
AISI (American Iron and Steel Institute)	$110.0	$100.0

* Iron Ore Cooperative Research Projects are matched 1:1 with non-state funding and are selected by a review committee consisting of the mining companies, the University of Minnesota, the US Bureau of Mines, and the State. Projects for FY90 will be selected in the spring of 1989.

MINERALS COORDINATING COMMITTEE
MINERAL DIVERSIFICATION
Last Revision: 1/12/89

Appropriation/Project	FY 88	FY 89	FY 90	Source	FY 91	Source	Project Manager
PROPOSED NON-FERROUS PROJECTS:							
Aeromagnetic Survey	$649.0	$135.0	$315.0	MFRC	$315.0	MFRC	MGS
Geologic Mapping and Drilling:							
Geo drilling, mapping (accel.)	$173.6	$176.4	$175.0	DNR-B	$175.0	DNR-B	MGS
Itasca Co. map & Geochronology			$110.0	MCC-C	$110.0	MCC-C	MGS
Cook area map			$65.0	DNR-C	$65.0	DNR-C	MGS
Geochemistry:							
Strategic mineral geochemistry	$98.0	$98.0					
Geochemical relationships between platinum group elements and iron titanium deposits in Partridge River area			$150.0	MCC-C	$150.0	MCC-C	NRRI
Glacial till geochemistry	$75.0	$75.0	$75.0	DNR-B	$75.0	DNR-B	DNR
			$40.0	DNR-C	$40.0	DNR-C	
			$30.0	MCC-C	$30.0	MCC-C	
Bedrock Geochemistry	$31.0	$69.0	$50.0	DNR-B	$50.0	DNR-B	NRRI
			$100.0	MCC-C	$100.0	MCC-C	
Airborne spectral radiometry		$25.0	$75.0	MFRC	$75.0	MFRC	NRRI
Non Ferrous Minerals Processing:							
Ilmenite processing	$30.0	$100.3	$50.0	MCC-C	$50.0	MCC-C	MRRC
PGE mineralogy identification with QEM-SEM			$75.0	MCC-C	$75.0	MCC-C	MRRC
Data Acquisition and Analysis:							
Drill core examination and assay (accel.)	$33.8	$50.0	$50.0	DNR-B	$50.0	DNR-B	DNR
			$65.0	MCC-C	$65.0	MCC-C	
Minerals Data Base (accel.)	$.0	$50.0	$25.0	DNR-B	$25.0	DNR-B	MCC
			$25.0	DNR-C	$25.0	DNR-C	
			$75.0	MCC-C	$75.0	MCC-C	
Acquisition of private exploration data			$75.0	MFRC	$75.0	MFRC	DNR
Mineral Deposit Models Seminar		$39.4	$40.0	DNR-B	$.0	DNR-B	MGS
Graphite with precious metals			$25.0	MCC-C	$25.0	MCC-C	MGS
Gold Economics Study		$22.5					
Environmental Research:							
Non-ferrous reclamation research			$25.0	DNR-B	$25.0	DNR-B	DNR
			$50.0	DNR-C	$50.0	DNR-C	
			$40.0	MCC-C	$40.0	MCC-C	
Non-ferrous permit simulation		$150.0					PCA/DNR
Economic Development Assistance:							
Minerals Industry Specialist			$43.7	T & ED	$43.8	T & ED	T & ED
Funding by Source:							
DNR-B			$465.0		$425.0		
DNR-C			$205.0		$205.0		
MCC-C			$670.0		$670.0		
MFRC			$465.0		$465.0		
T & ED (Trade and Economic Development)			$43.7		$43.8		

MINERALS COORDINATING COMMITTEE
MINERAL DIVERSIFICATION
Last Revision: 1/12/89

Appropriation/Project	FY 88	FY 89	FY 90	Source	FY 91	Source	Project Manager
ACCELERATED MINERAL LEASING:							
Accelerated leasing			$45.0	DNR-C*	$45.0	DNR-C*	DNR
			$125.0	MCC-C**	$125.0	MCC-C**	
Improved ownership records - St. Louis county		$50.0	$40.0	MFRC	$40.0	MFRC	DNR/SLCo.
Severed mineral identification (accel.)			$25.0	DNR-B	$25.0	DNR-B	DNR
			$25.0	DNR-C	$25.0	DNR-C	
			$25.0	MCC-C	$25.0	MCC-C	
Funding by Source:							
DNR-B			$25.0		$25.0		
DNR-C			$70.0		$70.0		
MCC-C			$150.0		$150.0		
MFRC			$40.0		$40.0		

* Industrial mineral lease rules
** Accelerated non-ferrous mineral leasing

MINERALS COORDINATING COMMITTEE
MINERAL DIVERSIFICATION
Last Revision: 1/12/89

Appropriation/Project	FY 88	FY 89	FY 90	Source	FY 91	Source	Project Manager
PROPOSED INDUSTRIAL MINERALS PROJECTS:							
Aggregate studies:							
Sand/gravel county inventory			$20.0	DNR-B	$20.0	DNR-B	DNR
			$40.0	DNR-C	$40.0	DNR-C	
Sand/gravel restoration practices			$50.0	MCC-C	$50.0	MCC-C	DNR
High-value industrial mineral surveys and marketing:							
Cement raw material & products			$25.0	DNR-C	$25.0	DNR-C	MRRC
			$55.0	MCC-C	$55.0	MCC-C	
Carbonate resource regional assessment	$68.0	$128.5	$50.0	DNR-B	$50.0	DNR-B	NRRI
Regional surveys/product development of MN clay	$196.0	$196.0	$40.0	DNR-B	$40.0	DNR-B	MRRC/NRRI
			$35.0	DNR-C	$35.0	DNR-C	
			$135.0	MCC-C	$135.0	MCC-C	
Dimension stone expansion			$50.0	DNR-BIM	$50.0	DNR-BIM	DNR
Competitive markets for industrial minerals			$20.0	MCC-C	$20.0	MCC-C	NRRI
Peat marketing study	$50.0	$50.0	$50.0	DNR-BIM	$50.0	DNR-BIM	DNR
Peat development environmental monitoring	$70.0	$72.0	$22.0	DNR-BIM	$22.0	DNR-BIM	DNR
Silica resource assessment			$25.0	MCC-C	$25.0	MCC-C	NRRI
Waste Product Utilization:							
Peat product development (poultry project)			$65.0	MFRC	$65.0	MFRC	NRRI
Synthetic aggregates from industrial waste			$40.0	MCC-C	$40.0	MCC-C	MRRC

Funding by Source:		
DNR-B	$110.0	$110.0
DNR-C	$100.0	$100.0
DNR-BIM (DNR BASE-Industrial Minerals)	$122.0	$122.0
MCC-C	$325.0	$325.0
MFRC	$65.0	$65.0

MINERALS COORDINATING COMMITTEE
MINERAL DIVERSIFICATION
Last Revision: 1/12/89

Appropriation/Project	FY 88	FY 89	FY 90	Source	FY 91	Source	Project Manager
Minerals Forum		$10.0					DNR
Basic Research:			$90.0	DNR-B	$90.0	DNR-B	
			$50.0	DNR-C	$50.0	DNR-C	
			$220.0	MCC-C	$220.0	MCC-C	
Mineral Potential of Felsic Rocks In NE Minnesota		$12.0					UofM
Fluid inclusions from Vermillion Fault System and gold potential		$12.0					UofM
Graphite investigations: East Central Minnesota		$14.0					UofM
Grinding media wear and its effect on copper-nickel Duluth Gabbro flotation		$14.0					UofM
Maganiferous Ores	$4.9	$5.4					UofM
Diamond-bearing Kimberlites	$13.7	$2.6					UofM
Automated Material Balance	$10.4						UofM
PGM Beneficiation	$15.6	$8.5					UofM
PGM Mineralogy	$11.0						UofM
Mineral Resource Appraisal	$11.7	$18.8					UofM
Fire Assay Spectrometry	$24.9						UofM
U of M Administration	$8.0	$2.0					UofM

Funding by Source:		
DNR-B	$90.0	$90.0
DNR-C	$50.0	$50.0
MCC-C	$220.0	$220.0

Total Funding by Source:			
DNR-B (Dept of Nat'l Resources BASE level request)	$790.0	$750.0	$1,540.0
DNR-C (Dept of Nat'l Resources CHANGE level request)	$525.0	$525.0	$1,050.0
DNR-BIM (DNR BASE-Industrial Minerals)	$122.0	$122.0	$244.0
MCC-C (Coordinating Committee Diversification CHANGE Request)	$2,000.0	$2,000.0	$4,000.0
MFRC (Minnesota Future Resources Commission)	$670.0	$670.0	$1,340.0
COOP (Iron Ore Cooperative Research)	$307.0	$307.0	$614.0
T & ED (Trade and Economic Development)	$43.7	$43.8	$87.5
IRRRB (Iron Range Resources and Rehabilitation Board)	$25.0	$25.0	$50.0
AISI (American Iron and Steel Institute)	$110.0	$100.0	$210.0

APPENDIX 2 - FY88-89 Diversification Program Status

Through Laws of Minnesota, 1987, Chapter 386, Article 7, the Legislature appropriated $1.0 million to Mineral Diversification for FY88-89. The Legislature also directed that the DNR's receipts from the Lease and Exploration Account be allocated to Diversification projects. Other funding for Diversification projects in FY88-89 included: the Minnesota Future Resources Commission, Iron Ore Cooperative Research matching funds, and state and private funding for the non-ferrous permit simulation project. Funding sources and expenditures by objective area are detailed

MINERAL DIVERSIFICATION PROGRAM
Budget Status FY 88-89 (in 1,000s)

Funding Sources	MFRC (a)	DNR-B (b)	COOP (c)	OTHER	TOTAL
Objectives					
Ferrous	$20.6	$25.4	$606.0	$697.7(d)	$1,349.7
Non-ferrous	$980.0	$1004.4		$250.0(e)	$2,234.4
Industrial Minerals	$392.0	$441.8			$833.8
Basic Research		$189.5			$189.5
TOTAL	$1,392.6	$1,661.1	$606.0	$947.7	$4,607.4

(a) Minnesota Future Resources Commission

(b) DNR BASE level request includes $1.0 million from the minerals portion of the Rural Development Act, $242.0 from Industrial Mineral Development funding in the DNR Minerals Division budget, and $409.1 estimated expenditures in the DNR Lease and Exploration Account. The Lease and Exploration Account is a revolving account from general fund receipts from mineral leases.

(c) Iron Ore Cooperative Research

(d) Represents matching funds received

(e) Permit Simulation Project, includes $100.0 matching funds from environmental groups and private foundations.

in the table below.

Current Mineral Diversification projects are briefly described in the following list. Project status reports are available from the Department of Natural Resources, Division of Minerals.

OBJECTIVE 1 - Current Projects to Improve and Extend Minnesota's Iron Industry

Product Quality:

- Development of digital image interpretation unit. Investigated digital image analysis for controlling the crushing and balling of taconite ores. (DNR-B, other)

Value Added:

- COREX - A project that evaluated the feasibility of building a COREX plant and associated steel mill in northeastern Minnesota. (MFRC, DNR-B)

Iron Ore Cooperative Research:

- Rod mill/ball mill conversion project. Improvements in ore crushing at Minnesota taconite plants may permit elimination of rod milling and the conversion of rod to ball mills, thus lowering costs. (COOP, other)
- Water chemistry impacts on taconite production. This program investigated the impact of various water chemistry components on taconite ore flotation and pellet binder performance. (COOP, other)
- High temperature properties of acid pellets. Examines the specific effects of pellet size, tumble strength, porosity, and organic binder/limestone additions on pellet quality. (COOP, other)
- Slagging Combustor Evaluation. This program is reviewing research and development of lower-fuel-cost slagging combustion systems by coal burning utilities to determine the applicability of these to taconite operations in Minnesota. (COOP, other)
- Moisture meter review. A project to evaluate the scientific principles and associated instrumentation for measuring moisture in taconite concentrate filter cake. (COOP)
- Evaluation of PAR-TEC 200 Particle Size Analyzer. Evaluation of an analytic instrument that has the potential to provide a low cost way to control particle size in taconite concentrators. (COOP, other)
- Fluxed pellet filtration study. One of several studies to seek cost reduction in fluxed pellets by controlling taconite concentrate filter cake moisture based upon on-stream particle size measurement. (COOP, other)
- Secondary grinding study. To evaluate effects of slurry solids concentration, mill ball sizes, and other factors on secondary grinding mill operation. (COOP, other)
- Low silica concentrates project. To estimate the additional cost of producing pellets with silica concentrations reduced from their present 5 percent to from 2 to 4 percent, to satisfy recent steel mill demands. (COOP, other)
- Oxygen enrichment study. To investigate the effects of oxygen injection, during pellet preheating, on final pellet quality. (COOP, other)

OBJECTIVE 2 - Current Projects to Encourage Exploration and Development of Non-ferrous Metallic Minerals

Aeromagnetic Surveying Program.

- In the fifth biennium of this program two large blocks of coverage were added, increasing knowledge of bedrock geology of interest to mineral exploration companies. (MFRC)

Geologic Mapping and Drilling:

- Accelerated geologic drilling and mapping. To produce a 1:250,000 scale geologic map of an area encompassing northern Itasca, southern Koochiching, and northeastern Beltrami counties. (DNR-B)

Geochemistry:

- Strategic mineral geochemistry. To test regional geochemical methods to evaluate strategic mineral potential of the Duluth Complex. (MFRC)
- Glacial till geochemistry. A continuing project, which, in FY88-89, yielded information on gold that beneficially influenced competitive bidding in the most recent lease sale. (DNR-B)
- Bedrock geochemistry. Investigated the Deer Lake Complex within the Itasca greenstones, Itasca County. (DNR-B)
- Airborne spectral radiometry. An airborne survey conducted as part of a research project to identify vegetative stress produced by heavy metals in soils. Heavy metals may indicate mineral deposits. (DNR-B)

Non-ferrous Minerals Processing:

- Ilmenite processing. To characterize Minnesota ilmenite (titanium ore) resources and prepare concentrates for added value process research. (DNR-B)

Data Acquisition and Analysis:

- Drill core examination and assay. Evaluation and analysis of drill core in the Hibbing Drill Core Library have identified significant base and precious metals mineralization. (DNR-B)
- Minerals data base. A project to unify the data bases of the Minerals Coordinating Committee member agencies for Minnesota's mineral community. (DNR-B)
- Mineral Deposit Models Seminar. A symposium will be convened in April, 1989 to evaluate mineral deposit models pertaining to gold and platinum group minerals that might lead to Minnesota discoveries. (DNR-B)
- Gold economics study. An examination of the secondary economic impacts Minnesota that gold mining would create. (DNR-B)

Environmental Research:

- Non-ferrous permit simulation. To anticipate new precious metals development proposals by modeling data needs and the permit acquisition process. (Other)

Accelerated Mineral Leasing:

- Improved ownership records in St. Louis County. To facilitate leasing and land availability for mineral exploration. (DNR-B)

OBJECTIVE 3 - Current Projects to Enhance Minnesota's Industrial Minerals Industry

High-value industrial mineral surveys and marketing:

- Carbonate resource regional assessment. A study to define the potential of Minnesota's carbonate rocks for lime production, flux, fillers, and other products. (DNR-B)
- Peat marketing study. To create a Minnesota identity in domestic and international peat markets. (DNR-B)
- Peat development environmental monitoring. Assessed the environmental site feasibility of two potential fuel peat production sites. (DNR-B)
- Clay Project. A multi-agency effort to develop a regional assessment of Minnesota clay resources, carry out processing research related to production of paper grade kaolin products from local kaolin resources, and to identify environmental and market aspects of a potential kaolin industry in the Minnesota River Valley region. (MFRC)

THE MINNESOTA MINERALS FORUM

- A cooperative effort of industry, government, and citizen groups to examine and suggest improvements in Minnesota's mineral economy. (DNR-B)

CURRENT BASIC RESEARCH PROJECTS

- Mineral potential of felsic rocks in northeast Minnesota. To assess the potential of felsic rocks for precious and base metal mineralization. (DNR-B)
- Fluid inclusions as indicators of gold potential in the Vermilion fault system. To use fluid inclusions as guides to gold exploration. (DNR-B)
- Graphite investigations in east central Minnesota. To assess the resource potential of Minnesota graphites. (DNR-B)
- Grinding media wear and its effects on copper-nickel Duluth Gabbro flotation. To improve the recovery of base metals from gabbroic rocks. (DNR-B)
- Manganiferous ores. To examine petrologic and mineralogic attributes of the manganiferous ores of the Cuyuna Range. (DNR-B)
- Diamond-bearing kimberlites. To assess potential for the occurrence of diamonds in Minnesota rocks. (DNR-B)

- Automated material balance. To extend the automated material balances program for use on micro-computers. (DNR-B)
- PGM beneficiation. To improve the recovery levels of platinum group metals in Minnesota rocks. (DNR-B)
- PGM mineralogy. To define exploration targets for platinum group metals in northeast Minnesota. (DNR-B)
- Mineral resource appraisal. Mathematical modeling of mineral resource occurrences. (DNR-B)
- Fire assay spectrometry. To refine methods of analysis for gold, silver, and platinum group metals. (DNR-B)