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MINNESOTA MINERAL DIVERSIFICATION

BIENNIAL FUNDING PLAN AND STATUS REPORT (FY92-93)

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MINNESOTA MINERALS COORDINATING COMMITTEE
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Pursuant to MS 93.002, subd 4(b)

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MINNESOTA MINERAL DIVERSIFICATION

Biennial Funding Plan and Status Report (FY92-93)

INTRODUCTION

This funding priority plan is a direct outgrowth of a planning process initiated by the Legislature to promote diversification of Minnesota's mineral resources (Minnesota Statutes, Sec. 93.001).

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 are charged with preparing a long range 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 provides the framework for mineral diversification in the long run. It addresses some of the steps that must be taken to meet our program objectives:

- **Ferrous Minerals** -- make the iron ore/taconite industries more competitive through improved process efficiencies and adoption of value-added product technologies,
- **Non-ferrous Minerals** -- attract new, non-ferrous (gold, platinum, and other minerals) mineral exploration and development ,
- **Industrial Minerals** -- enhance and expand the state's industrial minerals base.
- **Basic Research** -- to encourage research that aims at the longer-term mineral resources development potential in Minnesota.
- **Environmental Protection** -- to ensure that new mineral development satisfies the highest environmental quality standards.

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 accomplishments, 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. The members of the Minerals Coordinating Committee strive to balance mineral resource development activities with environmental protection, recognizing that no new mineral development is possible in Minnesota unless it meets the environmental review criteria and stringent permit requirements now in existence. To that end, the environmental research component of the FY92-93 biennial work plan is a strong one, dedicated to seeking answers to questions about the potential environmental effects of new mining, especially of mine wastes, and about the process by which new mining would be regulated and permitted. 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, needed insight on regional geology, mineral characterization and specific mineral processing and metallurgical 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 major commodity areas addressed in the Plan: ferrous, non-ferrous, and industrial minerals. The Advisory Committees advise the Minerals Coordinating Committee on the selection of worthwhile minerals projects, provide informed feedback on the progress of projects underway, and communicate industry concerns about minerals policy and planning.

The Minerals Coordinating Committee is developing a relationship 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, working with the recommendations of the industry advisory committees, about the concerns and issues outlined, and is a direct outgrowth of the process described in the Minnesota Mineral Diversification Ten Year Plan.

FUNDING PLAN COMPONENTS

FY90-91: Last biennium monies appropriated to the DNR for expenditure on Diversification projects implemented within the department and elsewhere amounted to $1,993.0 thousand. The sources of this sum were:

	(1,000s)
Base level funding	1,000.0
New general funds requested	500.0
General fund portion of Mineral Revenue account	493.0
Total	1,993.0

However, this amount was reduced in the interim Legislative Session (1990) by $258.0 thousand and further diminished by an unexpected shortfall in mineral revenues of $118.0 thousand. These reductions diminished the total to $1,635.0 thousand, as is shown in the table for FY90-91, below. This is the amount actually expended during the biennium on the three commodity project areas and basic research, listed in the column headed "DNR-Base". Expenditures under Iron Ore Cooperative Research (column "Coop-Res"), the Legislative Commission on Minnesota Resources (LCMR) and other sources, are also shown.

Impacts of FY90-91 Budget Cut

A specifically targeted cut ($200.0 thousand) foreclosed initiation of any new projects in FY91; there were a number well worth funding. A general cut of $58.0 thousand eliminated the second round of basic research funding, the projects for which are selected through a University peer review process.

The minerals revenue shortfall of $118.9 thousand resulted in cutbacks in various projects, including:

- evaluation of benefits to the iron mining industry of process temperature control, which increases volume and productivity;
- the monitoring of progress in value-added processing;
- a cutback of about 7% in geological drilling and mapping, the backbone of mineral potential geologic work;
- a project to design a minerals GIS (geographic information system);
- processing studies for kaolin clay.

The budget allocations for FY90-91 are shown in the table below.

MINERAL DIVERSIFICATION PROGRAM
Summary Budget Sheet FY90-91 (1,000s)

Source	DNR-Base	CoopRes	LCMR	Other	Total
Objectives:					
Ferrous	$302.0	$614.0	$200.0	$260.0	$1,376.0
Non-ferrous	$940.3		$860.0	$87.5	$1,887.8
Industrial Minerals	$271.0		$130.0	$244.0	$645.0
BasicResearch	$121.9				
Total	$1,635.2	$614.0	$1,190.0	$591.5	$3,908.8

FY92-93

Funding for Diversification projects in the coming biennium is requested from a number of sources. Funding requests for the "core" diversification projects are included in the *base* level request of the Minerals Coordinating Committee (in the table, below, MCC-Base, $1,640.0) and in the Coordinating Committee's *change* level request (MCC-Change, $3,817.3).

Additional funding for diversification projects is anticipated through the Legislative Commission on Minnesota Resources (see the LCMR column); the Iron Ore Cooperative Research Program (CoopRes column); and the American Iron and Steel Institute (Other column).

Funding needs total $7,036.3, which is a bit lower but essentially consistent with recommendations in the Ten-Year Plan. Of this amount $3,817.3 is new funding requests. According to Ten-Year Plan recommendations the MCC-Base and Cooperative Research funding will be allocated as follows: approximately 42% to ferrous minerals projects, 38% to non-ferrous projects, 14% to Industrial Minerals projects, and 6% to basic research.

MINERAL DIVERSIFICATION PROGRAM
Summary Budget Sheet FY92-93 (1,000s)

Sources	MCC Base	MCC Change	Coop Res	LCMR	Other	Total
Objectives:						
Ferrous	$325.0	$442.3	$621.0	$500.0	$480.0	$2,368.3
Non-ferrous	$865.0	$2,439.7		$108.0		$3,412.7
Industrial Minerals	$320.0	$935.3				$1,255.3
Basic Research	$130.0					
Total	$1,640.0	$3,817.3	$621.0	$608.0	$480.0	$7,036.3

OBJECTIVE 1 - Ferrous Minerals: Improve and Extend the Iron Ore Industry

Current Industry Status

The iron mining industry has rebounded from previous low production figures due to strong domestic demand for steel. During the low period the industry improved productivity, rationalized ownership, and introduced new technology to reduce costs. The past work showed that it is possible to improve the competitiveness of this important Minnesota industry. 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 will be about 44 million long tons in 1990. Most plants are at or near maximum capacity and the demand for Minnesota pellets looks strong for 1991.

However, the industry's links to the domestic steel industry make it 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. Also, the industry must look toward a future reduction in blast furnace use and concomitant increases in other iron-making technologies. Additional research to reduce impurity levels will be needed to ensure that Minnesota taconite is the raw material of choice for emerging technologies.

FY90-91 Accomplishments

Significant progress in:

- assessment of improved mining and crushing methods;
- pellet production process control technology and methods;
- appraisal of the economics and technology for producing low silica concentrates for pellet production;
- investigations toward the improvement of pellet characteristics and quality;
- evaluation of opportunities for added value products in Minnesota, such as iron carbide, iron, and semi-steel products;
- basic research objectives, such as automated metallurgical analysis;
- assessment of sources of corrosion in taconite pellet production equipment.

FY92-93 Priorities, Goals, & 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. However, use of flux has created side effects. Research will be needed to minimize the adverse effects of flux addition.

Research efforts supported by state agencies will continue to address the further development of low silica fluxed pellets as well as improvements in acid pellet production.

The overriding goals of the ferrous metals portion of the Minerals Diversification Program are:

- To improve the quality of Minnesota pellets as a blast furnace feedstock; and
- To ensure that changes in iron or steel making technology improve the market for Minnesota pellets.

The strategies to accomplish these two goals each 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, carbon addition or the use of lime hydrate;
* 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 crusher and concentrating costs by improved primary fragmentation in the mine, and grinding optimization;
* Improving process control systems for both concentration and agglomeration;
* Quantifying effects of water treatment on chemical consumption.

Work on iron ore is conducted by two programs. The Iron Ore Cooperative Research program focuses on shorter-term research that can be implemented quickly to solve immediate problems and produce immediate gains. The state's funds are matched with industry funds, and project selection, through industry membership on the Cooperative Research Committee, is driven by the needs of the iron mining industry. The ferrous metals portion of the Mineral 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 rank 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 available in the Cooperative Research Program. As can be seen from the lists above, the Committee has blended short and long-term needs to achieve a balanced research program in Mineral Diversification.

OBJECTIVE 2 - Non-ferrous Minerals: To Encourage Exploration and Development

Current Status

Minnesota is in global competition to attract mineral activity. Pursuit of new mineral resources usually occurs in areas with, among other things, the highest probability for discovery. Geologists have known 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 activity in Minnesota has been encouraged by the member agencies of the Minerals Coordinating Committee through developing and making available geologic and mineral potential information. With the awarding of leases bid upon at the October 1990 mineral lease sale, the total number of lessees exploring for non-ferrous minerals in Minnesota is 25. These companies range from Minnesota-based to international and vary greatly in size. Following award of leases in early 1991, exploration companies will have nearly 98,000 acres of state minerals under lease through over 268 separate leases in 8 counties. Significant acres of private and federal lands are under lease in addition to state lands. Exploration is focused primarily on precious metals such as gold, silver, platinum and palladium; although base metals (mainly copper and nickel) are also of interest.

FY90-91 Accomplishments

Significant Progress in:

- drilling and bedrock mapping of key mineral potential areas;
- the Minnesota aeromagnetic survey, funded by the Legislative Commission on Minnesota Resources, which provides critical data about buried bedrock, useful to mineral explorers;
- glacial drift (overburden) drilling and geochemistry;
- 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 repository);
- consideration of ore deposit models for gold, Platinum Group Elements, and base metal sulfides in Minnesota;
- distribution of information about Minnesota's mineral potential;
- evaluating regional mineral potential through regional geochemistry projects, such as the litho-geochemistry project in the Duluth complex.

- mineral ownership identification; and
- process technology research for Minnesota's ilmenite resources

FY92-93 Priorities, Goals, and Strategies

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

Acceleration of the efforts to upgrade the quality and accessibility of mineral ownership information will continue to be a high priority. The program locates (through legal research) state-owned mineral rights that can then be offered for leasing with the confidence that conflicts over ownership are reduced. These activities encourage and attract new mineral activity to the state.

Because exploration progress increases the likelihood of a discovery, it is critical to ensure environmentally sound development and reclamation of mined lands. Therefore, emphasis will be placed on research, such as the prediction and prevention of acid mine drainage, to address these issues in advance of development proposals.

Also, processing research will be conducted to assure that Minnesota has access to and can accommodate the latest technologies for mineral and metallurgical processing.

OBJECTIVE 3 - Industrial Minerals: To Enhance Minnesota's Industrial Minerals Industry

Current Industry Status

Minnesota's industrial minerals industry produces commodities valued at over $135 million annually. 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, the industry is making considerable effort to expand production, broaden markets, and acquire larger resource positions. Examples include the opening of kaolin pits and active exploratory drilling programs for high-grade kaolin deposits in southern and central Minnesota, active sampling of rock outcrops for new quarries by the dimension stone industry, and recent investments in the state's horticultural peat industry by Canadian firms.

In addition to the state's 450 natural sand and gravel pits; kaolin pits in Brown and Redwood counties provide material for cement and brick industries; approximately 60 quarries produce crushed rock; about a dozen quarries produce dimension stone, granite and dolomitic limestone which is marketed nationally; and the state's horticultural peat is found in markets throughout the U.S.

FY90-91 Accomplishments

Significant Progress in:

- identifying sand and gravel resources for land use planning
- kaolin clay resource identification and product quality investigations
- exploring carbonate resource use
- finding new sources for dimension stone
- horticultural peat facilities expansions
- trade and tariff initiatives to support the domestic stone industry

FY92-93 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 resources assessment programs, e.g., clays, silica, and dimension stone.
- provide an economic assessment of the current state of industrial minerals in Minnesota.

- Conduct research to determine the market categories for Minnesota's industrial minerals to guide product development. Without a better understanding of the physical and chemical characteristics of industrial minerals, additional product related research will be limited. A complete assessment of these industrial minerals is top priority.
- Improve stone quarrying and processing methods to reduce costs and environmental impacts, such as noise and dust.
- Also, continued emphasis will be placed on adopting new leasing systems for certain high-grade industrial minerals and oil and gas.

With the broad goal of enhancing the state industrial mineral industry, the Minnesota Minerals Coordinating Committee has identified five wide-ranging issue areas that need to be addressed to achieve the overall objective. These areas encompass:

- geological resource assessment,
- product development,
- marketing,
- technical requirements, and
- governmental requirements.

MINERAL DIVERSIFICATION BASE AND CHANGE LEVEL PROJECT PROPOSALS FY92-93

Projects Designed to Improve and Extend Minnesota's Iron Industry

Product Quality:

- **Super concentrates.** To achieve extremely low impurity (silica) levels in taconite concentrate. One to one and a half percent silica is the goal.
- **Trace Minerals in Fluxed Taconite Pellets.** Identification of trace minerals in taconite fluxes is important for the evaluation of processes to lessen corrosion of grate bars.
- **Evaluation of Silicate Materials in Taconite Flotation Products.** The use of polarized light microscopy to evaluate the behavior of silicates and carbonate minerals in froth flotation.

Process Technology:

- **Innovative comminution techniques.** To test new methods of crushing and grinding for applicability to taconite processing.
- **Effect of Improved Classification On Grinding Efficiency**. To increase the efficiency of fine grinding mills by reducing the recirculation of fine particles. e.g.: reduced over-grinding and production of excessive fines.
- **Effect of Water Treatment on Flotation and Green Ball Quality.** To quantify the effects of water treatment on reducing chemical consumption in taconite flotation and reducing pellet binder consumption.
- **Taconite Comminution Based on Interacting Vortices.** To investigate the potential of a comminution technique that may reduce specific energy consumption and reduce comminution mill wear.
- **Control systems improvement.** To improve measurement and feedback systems to reduce product variability.
- **Evaluation of In-Situ Blasted Taconite by Image Processing.** To quantify blast efficiency (size distribution) dynamically using digital devices to improve crushing, grinding, and agglomeration.
- **Taconite as De-sulfurization Agent in Industrial Combustors.** To evaluate taconite as a sulfur removal agent when using high sulfur coals.

Value Added:

- **Novel Iron-Making Phase II.** To examine the technical feasibility of critical, functional elements in a new, Minnesota-based iron-making technology.
- **Value-added Technology Evaluation.** To track new and developing technologies with the aim of encouraging development in Minnesota.

FY 92-93 Iron Ore Cooperative Research :

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

- Development of Improved Methods for Classification According to Particle Size
- Acid Pellet High Temperature Property Improvement
- Oxygen Enrichment
- Reducing the Effects of Corrosion
- Improving Productivity While Producing Fluxed Pellets
- Improving Control of Moisture Content and Size of Green Pellets
- Improving Iron Recovery at the Mine

Projects To Encourage Exploration and Development of Non-Ferrous Metallic Minerals

Geochemistry:

- **Gold and Base Metal Potential of Early Proterozoic Rocks.** A study of the gold and base metal potential of early proterozoic rocks in East-Central Minnesota. This will be a systematic, comprehensive litho-geochemical evaluation.
- **Glacial drift geochemistry.** The continuation of a highly successful project to identify regional scale dispersal of gold and other metals in glacial overburden.
- **Geology and Geochemistry of the Southern Duluth Complex.** To assess the size, grade, and precious metal content of Southern Duluth Complex.
- **Characterization of Vanadium-bearing Oxide Intrusions.** Determine the feasibility of producing vanadium in Minnesota.
- **Petrochemical Study of Koochiching County Massive Sulfides.** This is an important regional study of massive sulfides (often rocks containing base and precious metals) to aid mineral evaluations.
- **Mineral Potential of the Protozoic Animikie Basin.** Existing drill core from former exploration projects provide a ready source of information about mineral potential. In this proposal the geology of the Animikie Basin (East-Central Minnesota) will be investigated.
- **Laterite Geochemistry Evaluation.** To investigate the effectiveness of laterite (soil) geochemical sampling as a guide to mineral potential of underlying rock.

Geophysics

- **Geophysical Aspects of Platinum Deposits.** As an aid to future exploration, this project will investigate and document the gravity, magnetic, and electrical characteristics of platinum deposits.
- **Magnetotelluric Survey.** To define the structural relationships of the Duluth Complex as a guide to exploration.
- **Subsurface Greenstone Belts in Southwestern Minnesota.** The possibility that potentially mineral-bearing greenstone belts might be present in the drift-covered southwestern part of Minnesota was not seriously considered until the completion of the Minnesota aeromagnetic survey. The present proposal will use the aeromagnetic findings as a guide to shallow drilling that will

provide a sound geologic basis for evaluating these subsurface rocks as mineral exploration targets.

Geologic Mapping and Drilling:

- **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 an important guide to understanding Minnesota's geology, and are essential for mineral potential evaluation and stimulation of exploration. The geologic maps that will be produced for this project area include 1) a NW Minnesota map; 2) a map of the South Kawishiwi Intrusion based on a survey of area geology and stratigraphy; 3) a bedrock geologic map of the Duluth area; and 4) a Quaternary map (glacial till map) of North Central Minnesota.
- **Pseudo-geologic Maps.** An efficient and inexpensive technique for the preparation of maps from aeromagnetic and other geologic data to guide bedrock and overburden drilling.

Non Ferrous Minerals Processing:

- **Flotation of Platinum-Group Minerals.** To provide basic information that may make it possible to avoid extraction losses when processing platinum-group metals minerals.
- **Cuyuna Range Manganese Leaching.** Manganese, a critical mineral, occurs in large reserves in the Cuyuna Range. This project will examine the recovery of residual iron and/or manganese from tailings and the need for environmental monitoring of these processes.
- **Characterization of Manganese Minerals in Minnesota Iron Formations.** To perform detailed mineralogical characterizations of manganese in the Emily District so that an optimizing process for upgrading the resource may be designed.
- **Bio-Technology Applied to Manganese and Copper-Nickel Mining.** To demonstrate bio-accumulation as a control for heavy metals release from waste rock piles and abandoned mines.

Data Acquisition and Analysis:

- **Drill core examination and assay.** Analyses will focus on base and precious metal mineralization, associated alteration, and barren country rock.
- **Computerized Resource Estimation.** To evaluate the automation of resource estimation based on drill hole information.
- **Early Proterozoic Gold Review.** A reconnaissance program in over 10 townships to assess the applicability of Finnish techniques to find gold mineralization.

- **Automated Light Microscopy Image Analysis.** To investigate a technology for quantitative analysis of iron silicate minerals and the iron oxides.

Environmental Research:

- **Control of Acid Mine Drainage.** To develop low-cost techniques to characterize mine wastes and eliminate acid drainage into lakes and streams.
- **Non-ferrous Waste Characterization.** To investigate the early evaluation of drainage water quality to expedite the control of impacts and regulatory decisions.

Mineral Leasing:

- **Severed Mineral Identification.** To continue the acceleration of DNR's on-going severed mineral program, which increases the amount of land the state may offer for mineral leasing that are free from adverse title claims.

- **Anorthosite as an Industrial Filler.** This project will assess whether Minnesota anorthosite could be used as a filler for paints, ceramics, plastics, rubber or glass.
- **Process Development for Minnesota Graphite Resources.** To evaluate the feasibility of producing acceptable graphite concentrates from the graphites of East Central Minnesota.
- **Upgrading Minnesota Silica Sands.** To develop a process to produce high-quality silica sands.

Projects to Enhance Minnesota's Industrial Minerals Industry

Aggregate studies

- **Sand/gravel county inventory.** Continuing detailed inventory work to document important deposits in counties outside the seven-county metro area experiencing rapid growth.
- **Sand/gravel restoration practices.** To reclaim several abandoned sand and gravel pits throughout the state using methods outlined in the Sand and Gravel Reclamation Handbook.
- **Sand and Gravel Suitability Study.** To locate and characterize high-quality deposits threatened by urban expansion.

High-value industrial mineral surveys and marketing

- **Characterization of Kaolin in Northern and Central Minnesota.** To evaluate potential for kaolin resources.
- **Beneficiation of Carbonate Resources.** To evaluate the production of high-purity carbonates for specific applications, such as a fluxstone for use in the taconite industry.
- **Industrial Minerals Market Study.** To identify and evaluate the current and potential markets for Minnesota's industrial minerals.
- **Dimension Stone Inventory.** To identify quarry deposits for leasing and development in response to the tremendous growth worldwide the industry is experiencing.
- **Industrial Applications for Minnesota Silica.** To evaluate the potential for silica utilization in conventional and unconventional industrial applications.
- **Industrial Minerals Economic Profile.** To establish a framework for reporting industry data.
- **Heavy Minerals Survey.** To determine the presence of indicator minerals to focus mineral potential evaluation activities, and to determine the presence of economic concentrations of heavy minerals in glacio-fluvial deposits currently mined for sand and gravel.
- **Production of Lightweight Aggregate from Incinerator Ash and sludge.** To help confront the problem of the disposal of fly ash and mill sludge solid wastes by their use to produce a lightweight aggregate.
- **Geophysical Responses of Clay to aid Exploration.** To assist the search for clay in areas covered by glacial overburden and Cretaceous sediments.

Basic Research

In recognition of the importance of basic research, the Minerals Coordinating Committee has committed a portion of the Mineral Diversification budget to a Basic Research Program. The basic research is managed by the University through the Earth Resources Committee, an arm of the University Council for Natural Resources. The Committee solicits proposals for minerals basic research from both the University and other Minnesota academic institutions. Submitted proposals are given peer review, and recommendations are forwarded to the Coordinating Committee for final approval.

FY90-91 Accomplishments

Progress has been made in the following project areas:

- Establishment of an image processing work station to provide state-of-the-art capabilities for the analysis and interpretation of gravity and aeromagnetic data.
- Studies of geological structures that may have diamond-bearing potential.
- Field work to study the basic geology and origination of the Greenwood Lake Area to improve basic knowledge of the Duluth Gabbro and its potential for economic mineralization.
- Mathematical formulation of mine production scheduling to seek a sequencing of ore and waste removal, during the medium term of mine life, that maximizes the present value of the ore reserve.
- Flotation studies and the application of electrochemical and surface analytical techniques to investigate the mechanisms governing recovery of platinum group minerals from the Duluth Gabbro.
- Examination of a novel separation approach using iron powder as a reagent for both differential and selective flotation of copper and nickel-bearing minerals from Duluth Gabbro samples.

FY 92-93 Priorities, Goals, and Strategies

The strength of the Basic Research Program is the broad scope of its research interest. Any project area that contributes to the technical knowledge base of mineral resource identification and development is encouraged. This scope includes work to develop methodologies for acquiring and analyzing geological, mineralogical or processing data - whether or not it is immediately applicable to current problems. The aim of the Basic Research Program is to encourage research in any discipline that aims at the longer-term mineral resources development potential in Minnesota.

APPENDIX :
Comprehensive Diversification Summary Spreadsheet

FERROUS PROJECTS -- Iron Ore Cooperative Research	FY87	FY88	FY89	FY90	FY91	FY92	FY93	Project Manager	Matching Funds	
Addition of Solid Fuels to Pellets:	$57.2							M. A. Hanna	Various	$103.3
Alternate Pellet Binders	46.8							NRRI	USX	47.6
Pellet Metallurgical Property Improvement (Series I)	49.2							Pickands Mather	PM	32.8
In-pit Magnetic Cobbing	30.0							Inland Steel	Various	80.0
Slagging Combustion in Minnesota Taconite Plants		$47.0						MRRC	FMI	10.0
Conversion of Rod Mills to Ball Mills (Phase I)		50.0	$13.2					NRRI	USX	63.2
Pellet Metallurgical Property Improvement (Series II)		40.0	33.1	$6.9				Pickands Mather	PM	80.0
Evaluation of On-stream Moisture Sensors		7.0						MRRC		
Impacts of Water Chemistry on Pellet Production		61.0						M. A. Hanna	Hanna	25.9
Moisture Control Based on Feed Forward Vacuum Filter Control			18.0					NRRI	USX	18.0
Evaluation of an On-stream Particle Size Analyzer			35.0					MRRC	FMI	10.5
Secondary Ball Mill Circuit Optimization			52.7					M. A. Hanna	Hanna	21.6
Development of a Digital Image Interpretation System			8.0					USBM	USBM/USX	105.0
Production of Low-silica Concentrate (Series I)			31.3	38.4				NRRI	USX	69.7
Oxygen Addition to Pellet Induration Systems			7.2	21.0				Pickands Mather	Various	212.0
Corrosion of Grate Castings During Fluxed Pellet Production					$71.5			UofM Corrosion Center	Various	27.8
Grate Bar Corrosion Study				42.0	9.0			M.A. Hanna	Hanna	24.0
Feasibility of Coarse Cobbing of Lean Ores				35.8				NRRI	USX	35.4
Conversion of Rod Mills to Ball Mills (Phase II)				25.4				NRRI	USX	25.4
Pellet Metallurgical Property Improvement (Series III)				40.0				Pickands Mather	PM	40.0
Production of Low-silica Concentrate (Series II)					37.5			NRRI	USX	37.5
Dry Cobbing of Rod Mill Feed					20.0			NRRI	USX	20.0
In-Plant Testing of the Partec 200					28.5			NRRI	Various	28.5
Digital Image Analysis (Series II)					7.0			LTV Steel	Various	123.0
Carbon Addition to Fluxed Pellets					22.5			Inland Steel	Inland	19.5
Improved Classification					30.0			Pickands Mather	PM	30.0
Pellet Metallurgical Property Improvement (Series IV)					50.0			Pickands Mather	PM	50.0
FY 92-93 Funding for Iron Ore Cooperative Research Projects						$310.5	$310.5	Est Industry Match FY92		400.0
Subtotal: FERROUS PROJECTS -- Iron Ore Cooperative Research:	$183.2	$205.0	$198.5	$209.5	$276.0	$310.5	$310.5			
Total Expenditures, Cooperative Research FY87 thru FY91					$1,072.2			Total Match FY87-91		$1,340.7

MINERALS COORDINATING COMMITTEE

FERROUS PROJECTS -- Mineral Diversification:	FY87	FY88	FY89	FY90	FY91	FY92	FY93	Project Manager	Source of Funds	
Product Quality:										
Use of Lime/Dolomite Hydrate for Pelletizing				$50.0	$50.0			NRRI		
AISI -- Less than 3% Silica Concentrates				137.7	322.3			DNR/NRRI/MRRC	AISI LCMR IRRRB	210.0 200.0 50.0
AISI -- Less than 3% Silica Concentrates PHASE II						$40.0	$40.0	NRRI	AISI MCC-Base	40.0 40.0
Characterization of Trace Minerals in Fluxed Taconite Pellets						21.6	21.6	MRRC	MCC-Change	
Evaluation of Silicate Materials in Taconite Flotation Products						9.4	9.4	MRRC	MCC-Change	
Process Technology:										
Effect of Temperature on Mineral Processing Unit Operations					66.0			NRRI		
Innovative Comminution Techniques						45.0	45.0	MRRC	MCC-Base	
Effect of Improved Classification on Grinding Efficiency						40.0	40.0	NRRI	MCC-Base	
Effect of Water Treatment on Flotation and Green Ball Quality						27.5	27.5	NRRI	MCC-Base	
Taconite Comminution Based on Interacting Vortices						34.7	34.7	MRRC	MCC-Change	
Control System Improvement						33.5	33.5	MRRC	MCC-Change	
Evaluation of In-situ Blasted Taconite by Image Processing						32.5	32.5	NRRI	MCC-Change	
Taconite as Desulfurization Agent in Industrial Combustors						89.5	89.5	MRRC	MCC-Change	
Value-Added:										
COREX		$27.7						DNR		
Novel Iron-Making Process				.9	124.1				MRRC UofM Match	125.0
Novel Iron-Making Phase II						250.0	250.0	MRRC	LCMR	
Value-added Technology Evaluation				5.7	5.3	10.0	10.0	DNR	MCC-Base	
Subtotal: FERROUS PROJECTS -- Mineral Diversification:		$27.7		$194.3	$567.7	$633.7	$633.7			

NON-FERROUS PROJECTS -- Mineral Diversification	FY87	FY88	FY89	FY90	FY91	FY92	FY93	Project Manager	Source of Funds
Geochemistry/Geophysics:									
Bedrock Geochemistry of the Western Margin Duluth Complex		$31.0	$69.0						
Bedrock Geochemistry of Archean Rocks in NE Minnesota				$50.0	$44.0			NRRI	
Gold and Base Metal Potential of Early Proterozoic Rocks						$12.5	$12.5	NRRI	MCC-Base
Glacial Drift Geochemistry				110.0	20.0	137.5	137.5	DNR	MCC-Change
Geology and Geochemistry of Duluth Complex (Island Lk-Wyman Cr)						120.0	120.0	NRRI	MCC-Change
Characterization of Vanadium-bearing Oxide Intrusions						107.5	107.5	NRRI	MCC-Change
Petrochemical Study of Koochiching County Massive Sulfides						100.0	100.0	NRRI	MCC-Change
Mineral Potential of the Protozoic Animikie Basin						87.5	87.5	NRRI	MCC-Change
Laterite Geochemistry Evaluation						77.5	77.5	NRRI	MCC-Change
Aeromagnetic Survey		649.0	135.0	315.0	315.0			MGS	LCMR
Airborne Spectral Radiometry			25.0					NRRI	
Geophysical Aspects of Platinum Deposits						55.0	55.0	MGS	MCC-Change
Magnetotelluric Survey						20.0	20.0	DNR	MCC-Change
Subsurface Greenstone Belts in SW Minnesota						60.0	60.0	MGS	LCMR
Geologic Drilling and Mapping:									
Geologic Drilling and Mapping (Base level)		176.5	173.5	175.0	153.0	162.5	162.5	MGS	MCC-Base
Geologic Drilling and Mapping, Cook Area				65.0	62.0			MGS	
Regional Geologic Support for Geochemical Mapping				23.5	26.5			MGS	
Glacial Drift Stratigraphy			8.0					MGS	
Geology/Stratigraphy of S. Kawishiwi Intrusion						75.0	75.0	NRRI	MCC-Base
Bedrock Geologic Mapping Duluth Area						67.5	67.5	MGS	MCC-Base
Quaternary Mapping of NC Minnesota						42.5	42.5	MGS	MCC-Base
Pseudogeologic Maps						24.0	24.0	DNR	MCC-Change
Minerals Processing:									
Ilmenite Project		30.0	93.5					MRRC	
Flotation of Platinum-Group Minerals						17.5	17.5	MRRC	MCC-Base
Cuyuna Range Manganese Leaching						57.5	57.5	DNR	MCC-Change
Characterization of Manganese Minerals in MN Iron Formations						28.4	28.4	MRRC	MCC-Change
Bio-technology applied to Manganese and Copper-Nickel Mining						25.0	25.0	MRRC	MCC-Change

MINERALS COORDINATING COMMITTEE

NON-FERROUS PROJECTS (Continued):	FY87	FY88	FY89	FY90	FY91	FY92	FY93	Project Manager	Source of Funds
Data Acquisition and Analysis:									
Drill Core Examination and Assay		$33.8	$50.0	$50.0	$50.0	$45.0	$45.0	DNR	MCC-Base
Public Sample Analysis Program		5.0	5.0					MGS	
Minerals Database			50.0	10.3				MCC	
Acquisition of Private Exploration Data				75.0	75.0			DNR	LCMR
Mineral Deposit Models Seminar		39.4						MGS	
Gold Economics Study (IPASS)			14.0					NRRI	
Duluth Complex Drill Core Analysis					21.0			DNR	
Computerized Resource Estimation						20.5	20.5	DNR	MCC-Change
Early Proterozoic Gold Review						47.5	47.5	DNR	MCC-Change
Automated Light Microscopy Image Analysis						52.0	52.0	MRRC	MCC-Change
Environmental Research:									
Non-ferrous reclamation research				20.0	20.0			DNR	
Non-ferrous permit simulation			150.0					DNR/PCA	
Control of Acid Mine Drainage						232.5	232.5	DNR	MCC-Change
Non-ferrous Waste Characterization						27.5	27.5	DNR	MCC-Change
Mineral Leasing:									
Improved Ownership Records, St. Louis County			50.0	40.0	40.0			DNR/StLCo	LCMR
Severed Mineral Identification				20.0	20.0	10.0	10.0	DNR	MCC-Base
Subtotal: NON-FERROUS PROJECTS -- Mineral Diversification:		$964.7	$823.0	$953.8	$846.5	$1,712.4	$1,712.4		

MINERALS COORDINATING COMMITTEE

INDUSTRIAL MINERALS PROJECTS -- Mineral Diversification	FY87	FY88	FY89	FY90	FY91	FY92	FY93	Project Manager	Source of Funds
Aggregate studies:									
Sand/gravel county inventory/aggregate mapping				$20.0	$16.0	$30.0	$30.0	DNR	MCC-Base
Sand/gravel restoration practices				15.0	7.0	10.0	10.0	DNR	MCC-Base
Sand and Gravel Suitability Study						40.0	40.0	DNR	MCC-Base
Leasing:									
Leasing of Industrial Minerals				10.0	10.0			DNR	
High-value Industrial Mineral Surveys and Marketing:									
Carbonate Resource Evaluation		$68.0	$111.0					NRRI	
Regional Geologic Controls of Industrial Clay Grades				30.0	84.0			NRRI	
Kaolin Processing Research				35.0	44.0			MRRC	
Brochure: Kaolin Resources of the Minnesota River Valley				5.0	2.5			MN Riv Valley	
Peat Marketing Study		50.0	50.0	55.0	45.0			DNR	
Peat Development Environmental Monitoring		70.0	72.0					DNR	
Characterization of Kaolin in Northern and Central Minnesota						30.0	30.0	NRRI	MCC-Base
Beneficiation of Carbonate Resources						25.0	25.0	NRRI	MCC-Base
Industrial Mineral Market Study						5.0	5.0	NRRI	MCC-Base
Dimension Stone Inventory						20.0	20.0	DNR	MCC-Base
Industrial Applications for Minnesota Silica						100.0	100.0	NRRI	MCC-Change
Industrial Mineral Economic Profile						70.0	70.0	DNR	MCC-Change
Heavy Minerals Survey						67.0	67.0	DNR	MCC-Change
Production of Lightweight Aggregate from Incinerator Ash/sludge						66.3	66.3	NRRI	MCC-Change
Geophysical Responses of Clay for Exploration						50.4	50.4	NRRI	MCC-Change
Anorthosite as an Industrial Filler						42.5	42.5	NRRI	MCC-Change
Process Development for Graphite Resources of Minnesota						37.5	37.5	MRRC	MCC-Change
Upgrading Silica Sands of Minnesota						34.0	34.0	MRRC	MCC-Change
Waste Product Utilization:									
Peat product development (poultry project)				65.0	65.0			NRRI	LCMR
Subtotal: INDUSTRIAL MINERALS PROJECTS -- Mineral Diversification:		$188.0	$233.0	$235.0	$273.5	$627.7	$627.7		

MINERALS COORDINATING COMMITTEE

INDUSTRIAL MINERALS PROJECTS -- Mineral Diversification	FY87	FY88	FY89	FY90	FY91	FY92	FY93	Project Manager	Source of Funds
Aggregate studies:									
Sand/gravel county inventory/aggregate mapping				$20.0	$16.0	$30.0	$30.0	DNR	MCC-Base
Sand/gravel restoration practices				15.0	7.0	10.0	10.0	DNR	MCC-Base
Sand and Gravel Suitability Study						40.0	40.0	DNR	MCC-Base
Leasing:									
Leasing of Industrial Minerals				10.0	10.0			DNR	
High-value Industrial Mineral Surveys and Marketing:									
Carbonate Resource Evaluation		$68.0	$111.0					NRRI	
Regional Geologic Controls of Industrial Clay Grades				30.0	84.0			NRRI	
Kaolin Processing Research				35.0	44.0			MRRC	
Brochure: Kaolin Resources of the Minnesota River Valley				5.0	2.5			MN Riv Valley	
Peat Marketing Study		50.0	50.0	55.0	45.0			DNR	
Peat Development Environmental Monitoring		70.0	72.0					DNR	
Characterization of Kaolin in Northern and Central Minnesota						30.0	30.0	NRRI	MCC-Base
Beneficiation of Carbonate Resources						25.0	25.0	NRRI	MCC-Base
Industrial Mineral Market Study						5.0	5.0	NRRI	MCC-Base
Dimension Stone Inventory						20.0	20.0	DNR	MCC-Base
Industrial Applications for Minnesota Silica						100.0	100.0	NRRI	MCC-Change
Industrial Mineral Economic Profile						70.0	70.0	DNR	MCC-Change
Heavy Minerals Survey						67.0	67.0	DNR	MCC-Change
Production of Lightweight Aggregate from Incinerator Ash/sludge						66.3	66.3	NRRI	MCC-Change
Geophysical Responses of Clay for Exploration						50.4	50.4	NRRI	MCC-Change
Anorthosite as an Industrial Filler						42.5	42.5	NRRI	MCC-Change
Process Development for Graphite Resources of Minnesota						37.5	37.5	MRRC	MCC-Change
Upgrading Silica Sands of Minnesota						34.0	34.0	MRRC	MCC-Change
Waste Product Utilization:									
Peat product development (poultry project)				65.0	65.0			NRRI	LCMR
Subtotal: INDUSTRIAL MINERALS PROJECTS -- Mineral Diversification:		$188.0	$233.0	$235.0	$273.5	$627.7	$627.7		