



Environment and Natural Resources Trust Fund

2027 Request for Proposal

General Information

Proposal ID: 2027-262

Proposal Title: Securing Minnesota's Critical Minerals: Emily Manganese Deposit

Project Manager Information

Name: Joshua Feinberg

Organization: U of MN - College of Science and Engineering

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Project Basic Information

Project Summary: This project uses geophysics and advanced characterization to map the extent of Minnesota's high-grade Emily Manganese Deposit, securing a domestic battery-mineral supply while ensuring long-term environmental and social stewardship.

ENRTF Funds Requested: \$659,000

Proposed Project Completion: June 30, 2030

LCCMR Funding Category: Land (F)

Project Location

What is the best scale for describing where your work will take place?

Region(s): Central

What is the best scale to describe the area impacted by your work?

Region(s): Central

When will the work impact occur?

In the Future

Narrative

Describe the opportunity or problem your proposal seeks to address. Include any relevant background information.

This proposal addresses the critical vulnerability of the U.S. domestic supply chain for manganese, which is an essential element for Nickel-Manganese-Cobalt electric vehicle batteries and steel production. Despite its necessity for the green economy transition, the United States remains 100% dependent on foreign sources, which presents significant geopolitical and economic risks.

The Emily Iron Formation (EIF) in Minnesota's Cuyuna Range represents the highest-grade known manganese resource in North America. However, it remains significantly underused due to a lack of fundamental geological data. Knowledge gaps regarding its aerial extent, age, and enrichment mechanism impede efficient mineral processing and the development of responsible extraction strategies. In 2025 the USGS collected new high-resolution aeromagnetic data over the deposit, but these data require a geophysical model to be useful for mineral exploration.

Current mineral exploration often lacks the geochemical context that is essential to long-term environmental stewardship. By integrating magnetic techniques with advanced materials characterization, this study addresses the problem of inefficient domestic production while ensuring that the mineralogy is understood within its broader ecosystem. This approach shifts the focus from simple extraction to a sustainable, "just" energy transition that includes focus on priorities for environmental and social responsibility and protecting local economies.

What is your proposed solution to the problem or opportunity discussed above? Introduce us to the work you are seeking funding to do. You will be asked to expand on this proposed solution in Activities & Milestones.

This project will decode the Emily Iron Formation (EIF) using 180 new drill core samples. We will "ground truth" the 2025 USGS aeromagnetic data into a high-resolution 3D map of Minnesota's manganese reserves. We will correlate the magnetic properties and mineralogy of physical samples with aerial magnetic signatures. We will determine the specific mineral phases where manganese resides to decide if low-impact magnetic separation, rather than intensive chemical processing, is viable for this specific ore. Further, we will conduct accelerated weathering tests using simulated rainwater and groundwater to observe how metals might be mobilized if materials are unearthed. We will produce an Open-Access GIS database that provides a transparent, science-based framework for protecting Minnesota's groundwater while managing its mineral wealth.

Led by University researchers in coordination with cross-sector partners, we define project "success" as measured both by resource potential and long-term hydrogeological stability. The resulting digital products offer state regulators, tribal leadership, and surrounding communities an accessible, peer-reviewed map of the EIF. Using proactive environmental modeling and collaborative science, the project aims to minimize regulatory risk and prevent speculative mining, securing a transparent, data-driven future for Minnesota's mineral management.

What are the specific project outcomes as they relate to the public purpose of protection, conservation, preservation, and enhancement of the state's natural resources?

This project enhances Minnesota's natural resources by replacing reactive remediation with proactive stewardship:

We will improve understanding of the geographic extent of a critical mineral deposit within our state through a geophysical model of the EIF.

Predictive weathering models will provide data to the MPCA/DNR to safeguard groundwater from manganese mobilization before disturbance.

An open-access GIS database will integrate magnetic, mineralogical, and ecological data, ensuring state resources are managed with transparent, high-resolution science.

We will combine Western geology with Indigenous Knowledge to prioritize long-term ecosystem health.

A state-level white paper will provide a roadmap for a "just" energy transition.

Activities and Milestones

Activity 1: Geologic and Mineralogical Description of the Emily Deposit

Activity Budget: \$219,667

Activity Description:

This activity establishes the geologic origin and stability of manganese within the Emily Iron Formation using magnetic measurements and advanced characterization techniques. Geophysicists can predict how a deposit will appear in an aeromagnetic survey using two measurements: (1) the magnetic remanence (the magnetic "recording" of the samples), and (2) the magnetic susceptibility (how samples react to a magnet). We will perform measurements on 180 drill cores that we already have in hand. The data will allow us to construct a predictive model using industry standard software (Oasis Montaj) of how the EIF appears in the aeromagnetic surveys. In addition, these measurements will allow us to distinguish between magnetizations acquired when the rocks originally formed 1.8 billion years ago as compared to later, when manganese was concentrated and "enriched" by water movement.

Understanding this history is vital for conservation; it tells us how stable these minerals are in the ground and how they might react if disturbed. To ensure the highest accuracy, we will synthesize "synthetic mineral standards," which are pure lab-grown versions of the minerals, to compare against our field samples.

Activity Milestones:

Description	Approximate Completion Date
A high-resolution magnetic mineralogy map of the Emily deposit.	July 31, 2028
Dating of the manganese mineralization event.	October 31, 2028
Peer-reviewed publication of a geophysical model of the Emily Deposit.	July 31, 2029

Activity 2: Nano-Scale Chemical Mapping

Activity Budget: \$219,667

Activity Description:

This activity establishes a rigorous technical baseline for the EIF through an unprecedented partnership between BGE, Macalester College, and the University of Minnesota. By integrating advanced light imaging, micro-X-Ray Fluorescence (μ XRF), and high-resolution electron microscopy, our team will map the manganese enrichment from the regional scale down to the nano-scale. This level of collaborative precision is rare in mineral exploration and ensures the state receives a sophisticated, data-driven mineralogical model.

A primary focus of this research is proactive environmental protection. We propose rigorous leaching experiments to simulate how minerals respond to rain and groundwater exposure. By determining exactly how manganese is chemically bonded, we provide the foundational data necessary for responsible, long-term state oversight.

These insights are essential for "green" processing. By identifying exact mineral species, we can design extraction methods that target only necessary materials, drastically reducing energy consumption and chemical waste. This proactive approach allows us to predict metal movement before any ground is disturbed, equipping the state with the tools to prevent water contamination and ensure the highest standards of environmental protection.

Activity Milestones:

Description	Approximate Completion Date
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Mineralogical catalog of Mn-oxide phases (pyrolusite, manganite, etc.)	July 31, 2028
Report of distribution / partitioning of Mn, Fe, and P	December 31, 2028
Publication describing results of simulated weathering experiments tracking the release of manganese and trace metals	September 30, 2029
A Reaction Pathway model predicting how these minerals behave when exposed to air and water	December 31, 2029

Activity 3: Framework for Collaborative, Proactive Stewardship

Activity Budget: \$219,666

Activity Description:

This activity synthesizes technical findings into a public-facing Open-Access GIS Database, transforming raw data into a transparent tool for state-wide decision-making. Central to this effort is a collaborative, multi-disciplinary approach that bridges the gap between lab science and community knowledge. We will work closely with Aaron Hirsch and the Minnesota Geological Survey (MGS) to ensure our mineralogical models align with state-level geological frameworks. In particular, we will ensure that the high-resolution model is informed by and improves existing county geologic atlases for Crow Wing and Aitkin counties and agrees with the larger USGS-funded Earth Mapping Resources Initiative Cuyuna Range project being led by the MGS.

We aim for meaningful engagement with the Emily, Minnesota community and with Tribal NRDs (Natural Resource Departments) through formal consultations and knowledge-sharing. We will organize and facilitate local workshops aiming to integrate community concerns and observations into our environmental models. By grounding future land-use decisions in peer-reviewed science rather than guesswork, this digital resource provides Tribal governments, state agencies, and local citizens with a shared "source of truth." This proactive integration reduces regulatory uncertainty and prevents speculative mining, leading to a responsible, community-led template for managing Minnesota's critical mineral wealth.

Activity Milestones:

Description	Approximate Completion Date
Integrate Emily Deposit data into existing Minnesota Geological Survey digital frameworks.	July 31, 2028
Host two public forums in Emily to incorporate local concerns and observations into the project's	March 31, 2029
Deploy the open-access database featuring magnetic, chemical, and hydrogeological data layers.	May 31, 2029
Produce a shared map identifying critical groundwater and soil zones that require prioritized protection.	December 31, 2029
Deliver a summary of findings to the DNR and MPCA to support science-based mineral policy.	February 28, 2030

Project Partners and Collaborators

Name	Organization	Role	Receiving Funds
R. Lee Penn	University of Minnesota	Co-PI that will help supervise graduate students, prepare reports, and collect samples.	Yes
Aaron Hirsch	University of Minnesota	Co-PI that will help supervise graduate students and prepare reports.	Yes
Alex Steiner	Big Rock Exploration	Is providing access to previously collected drill cores from the Emily Iron Formation and sharing complementary mineral and chemical datasets.	No
Jeffrey Thole	Macalester College	Supervising undergraduates using Macalester College's μ XRF instrument to collect compositional information from rock samples from the Emily Iron Formation and collaborating on scientific interpretation.	No

Dissemination

Describe your plans for dissemination, presentation, documentation, or sharing of data, results, samples, physical collections, and other products and how they will follow ENRTF Acknowledgement Requirements and Guidelines.

This project will strategically disseminate data and results to all stakeholders. Technical data, geophysical modeling, and mineral stability data and results will be included in manuscripts submitted to peer-reviewed scientific journals and presented at scientific conferences. White papers containing both technical data and summaries accessible to the public will be produced for the state. Presentations will be made to local communities and Indigenous groups as part of the proposed knowledge exchange sessions. Materials from these presentations will be stored permanently in the Digital Repository of the University of Minnesota (DRUM).

Long-Term Implementation and Funding

Describe how the results will be implemented and how any ongoing effort will be funded. If not already addressed as part of the project, how will findings, results, and products developed be implemented after project completion? If additional work is needed, how will this work be funded?

Results will be implemented via an open-access GIS database and a white paper delivered to the Minnesota DNR and MPCA, providing a data-driven framework for sustainable mineral management. The integration of mineralogical weathering models and "Two-Eyed Seeing" protocols will lead to the development of tools that will guide state permitting and tribal consultation processes.

The pilot data generated will be leveraged to secure long-term funding from federal agencies (NSF/DOE) specifically targeting "Sustainable Energy Transitions." Ongoing maintenance of the GIS repository and expanded site testing will be supported through these federal grants and continued University-Tribal-Industrial partnerships, ensuring the project's lifespan.

Other ENRTF Appropriations Awarded in the Last Six Years

Name	Appropriation	Amount Awarded
Citizen Scientists Capture Microplastic Pollution Around State	M.L. 2025, First Special Session, Chp. 1, Art. 2, Sec. 2, Subd. 04p	\$419,000

Project Manager and Organization Qualifications

Project Manager Name: Joshua Feinberg

Job Title: Professor of Earth & Environmental Sciences.

Provide description of the project manager's qualifications to manage the proposed project.

Feinberg is the Director of a NSF national multi-use center at the University of Minnesota called the Institute for Rock Magnetism (IRM), which since 1991 has served as an international hub for studying the magnetic properties of natural and synthetic materials. The staff at the IRM provide access and training to one of the world's most comprehensive collections of magnetic instrumentation, which is ideally suited for studying samples from the Emily manganese deposit. Feinberg has served as a faculty member at the University of Minnesota since 2007 and routinely serves as the primary project manager for state and federally funded science projects, supervising graduate students, postdoctoral scholars, and undergraduate students at the University of Minnesota, and coordinating with collaborators in private industry, community partners, state and federal regulatory agencies, and other educational institutions. His research output has been sufficient to be recognized as a University of Minnesota McKnight Distinguished Professor.

Organization: U of MN - College of Science and Engineering

Organization Description:

The University of Minnesota College of Science and Engineering (CSE) is a premier, top-20 ranked institution combining 12 engineering, physical science, mathematics, and computer science departments. Offering 20+ bachelor's degrees and numerous graduate programs, it serves over 7,000 students. Renowned for hands-on research, it integrates academic theory with practical application, including robust co-op/internship programs. CSE provides a highly collaborative, interdisciplinary environment in the Twin Cities, fostering innovation, leadership, and high post-graduation employment rates within technical fields.

Budget Summary

Category / Name	Subcategory or Type	Description	Purpose	Gen. Ineligible	% Benefits	# FTE	Classified Staff?	\$ Amount
Personnel								
Project Lead (Prof. Joshua Feinberg)		Project manager and supervisor of graduate and undergraduate students			38.5%	0.6		\$120,289
Co-Investigator (Prof. Lee Penn)		Supervision of graduate student in University of Minnesota Chemistry			38.5%	0.6		\$132,470
Geophysics Specialist (Dr. Aaron Hirsch)		Supervision of the creation of a geophysical model of the Emily Deposit			38.5%	0.12		\$19,422
Graduate Student in Earth & Environmental Sciences		Measurement of magnetic properties and construction of geophysical model of Emily Iron Formation			28.9%	1.5		\$128,261
Graduate Student in Chemistry		Measurement and micro-characterization of minerals in the Emily Iron Formation and groundwater leaching experiments.			28.9%	0.75		\$74,922
Undergraduate Researcher		Collection of μ XRF mineral compositional data using instrument at Macalester College			0%	0.57		\$20,501
							Sub Total	\$495,865
Contracts and Services								
University of Minnesota Characterization Facility	Internal services or fees (uncommon)	Fees to use electron microscopes for nano- and micro-meter scale characterization of minerals in the Emily Iron Formation.				0.45		\$15,531
University of Minnesota Department of Chemistry	Internal services or fees (uncommon)	Internal fees for the use of a nuclear magnetic resonance (NMR) instrument to characterize water and mineral chemistry.				0.45		\$7,727
							Sub Total	\$23,258
Equipment, Tools, and Supplies								

	Equipment	Fluorospectrometer	To obtain measurements of water chemistry based on the absorption of light						\$4,999
	Tools and Supplies	Laboratory consumables	Preparation of samples for magnetic, mineral, and chemistry measurements.						\$15,531
	Equipment	Equipment repair and maintenance	To cover the cost of repair and maintenance of existing instrumentation in both the departments of Earth & Environmental Science and Chemistry						\$15,235
	Equipment	Annual software licensing fees for Oasis Montaj Basin Modeling	This is the industry standard software package used to process aeromagnetic and gravity data and to construct geophysical models that reproduce the collected data.						\$48,496
								Sub Total	\$84,261
Capital Equipment									
								Sub Total	-
Acquisitions and Stewardship									
								Sub Total	-
Travel In Minnesota									
	Miles/ Meals/ Lodging	Three trips (one during each of year of the project) to support community meetings in Emily, Minnesota. This includes travel to and from Minneapolis (284 miles per trip at a rate of \$0.725/mile) for 5 people. Each trip includes funding for meals (\$68/person) and lodging (\$110/person) using GSA rates for Emily, MN. Each community meeting includes \$500 for the rental of a meeting space in Emily.	These community meetings provide the project a chance to share information with the local communities that would be impacted by potential mining activities and to gather their thoughts and suggestions about how to proceed with the research.						\$4,917
								Sub Total	\$4,917
Travel Outside Minnesota									

							Sub Total	-
Printing and Publication								
	Publication	Publications costs for peer-reviewed journals at a rate of 1 publication per year.	Peer-reviewed publication to disseminate the results of this research.					\$9,273
							Sub Total	\$9,273
Other Expenses								
		Tuition remission for graduate students	Graduate student tuition costs					\$41,426
							Sub Total	\$41,426
							Grand Total	\$659,000

Classified Staff or Generally Ineligible Expenses

Category/Name	Subcategory or Type	Description	Justification Ineligible Expense or Classified Staff Request
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Non ENRTF Funds

Category	Specific Source	Use	Status	Amount
State				
			State Sub Total	-
Non-State				
			Non State Sub Total	-
			Funds Total	-

Total Project Cost: \$659,000

This amount accurately reflects total project cost?

Yes

Attachments

Required Attachments

Visual Component

File: [34ec6456-9fb.pdf](#)

Alternate Text for Visual Component

This graphic shows both a schematic of the community values and scientific outcomes of this critical minerals project, as well as the location of the Emily Iron Formation within the state of Minnesota and a map of where the manganese is currently thought to exist....

Supplemental Attachments

Capital Project Questionnaire, Budget Supplements, Support Letter, Photos, Media, Other

Title	File
Support Letter from Macalester College	9b072afa-96f.pdf
Institutional Support Letter	650730da-f60.pdf
Quote for Annual Software Licensing for Oasis Montaj	28dd8ded-c89.pdf
Support Letter from Big Rock Exploration	59621808-d52.pdf

Administrative Use

Does your project include restoration or acquisition of land rights?

No

Do you understand that travel expenses are only approved if they follow the "Commissioner's Plan" promulgated by the Commissioner of Management of Budget or, for University of Minnesota projects, the University of Minnesota plan?

Yes, I understand the UMN Policy on travel applies.

Does your project have potential for royalties, copyrights, patents, sale of products and assets, or revenue generation?

No

Do you understand and acknowledge IP and revenue-return and sharing requirements in 116P.10?

N/A

Do you wish to request reinvestment of any revenues into your project instead of returning revenue to the ENRTF?

N/A

Does your project include original, hypothesis-driven research?

Yes

Does the organization have a fiscal agent for this project?

Yes, Sponsored Projects Administration

Does your project include the pre-design, design, construction, or renovation of a building, trail, campground, or other fixed capital asset costing \$10,000 or more or large-scale stream or wetland restoration?

No

Do you propose using an appropriation from the Environment and Natural Resources Trust Fund to conduct a project that provides children's services (as defined in Minnesota Statutes section 299C.61 Subd.7 as "the provision of care, treatment, education, training, instruction, or recreation to children")?

No

Provide the name(s) and organization(s) of additional individuals assisting in the completion of this proposal:

Josh Gates, University of Minnesota Sponsored Projects Administrator

Do you understand that a named service contract does not constitute a funder-designated subrecipient or approval of a sole-source contract? In other words, a service contract entity is only approved if it has been selected according to the contracting rules identified in state law and policy for organizations that receive ENRTF funds through direct appropriations, or in the DNR's reimbursement manual for non-state organizations. These rules may include competitive bidding and prevailing wage requirements

N/A