2021 Presidential Faculty-Student Collaboration Grant Application

Application Deadline - 5 pm, Monday, February 22nd, 2021.

Please direct inquiries about applications to Sarah Wolter (swolter2@gustavus.edu).

Overview

Guidelines

Presidential Faculty-Student Collaboration Grants are available annually to support collaborative endeavors involving faculty and students.

*Grant monies may be used to support faculty summer stipends, summer compensation for students, student housing on campus, equipment, materials, transportation, etc.

*Applications will be accepted for stipends and project costs, and for stipends only.

*One faculty member cannot receive both the Research, Scholarship, and Creativity grant and the Presidential Faculty/Student Collaboration grant in the same year.

*Monies may also be used as matching funds for outside support awarded to the faculty member.

*Student eligibility is limited to full-time returning students.

*Grant recipients conducting research with human subjects must receive IRB approval prior to disbursement of grant funds; grant recipients conducting animal research must receive IACUC approval prior to disbursement of grant funds.

*Applicants whose previous grant reports are past due will not be eligible to apply.

*Awards are made in the spring for the following academic year; project expenses must be incurred and reimbursed during that fiscal year (June 1 - May 31).

Please see https://gustavus.edu/kendallcenter/grant-opportunities/grant-examples.php for examples of previously funded applications.

What does the Faculty Development Committee mean by "collaboration"?

Collaboration is understood to include in-depth faculty-mentored undergraduate scholarly or creative projects in any discipline. For the purposes of this grant, collaboration means the active involvement of the faculty member in the student's project. This might be a full-fledged faculty-student project partnership, a student project that is closely mentored by the faculty member, or a student's active and meaningful participation in an ongoing faculty research project. Successful proposals will demonstrate a mentoring relationship between faculty and student that encourages scholarly/creative work in a collaborative environment.

Criteria for selection

To distinguish among proposals that meet all criteria identified in the application, the committee looks for evidence of exceptional merit, compelling project design, impact on student experience, and feasibility of project. The committee encourages applications from all departments and disciplines, and from faculty at all stages. Priority will be given to quality proposals submitted by candidates who have not been funded through a Presidential Student/Faculty Collaboration grant in the past three years.

I. Personal Data

Faculty First Name *

Rory

Faculty Last Name *

McFadden

Faculty Gustavus E-mail *

rmcfadde@gustavus.edu

Faculty Campus Phone Number *

5079337335

Rank/Status *

- ( ) Visiting Faculty
- ( ) Continuing Instructor
- (•) Assistant Professor
- ( ) Associate Professor
- ( ) Full Professor

Faculty Department(s) and/or Program(s) *

Geology

Administrative Assistant Name *

Jennifer Kruse

Student First Name *

Hannah

Student Last Name *

Schroeder

Student Gustavus E-mail *

hschroed@gustavus.edu

Student Major(s) *

Geology

Anticipated Graduation Year *

2022

II. Information on Previous Grants & Permission to Share Proposal

To be completed by the faculty member applicant.

Have you previously received a Presidential Faculty/Student Collaboration Grant? *

- ○ Yes
- ◉ No

If you replied "yes" to the previous question, briefly describe your previous Presidential Faculty/Student Collaboration Grant project(s) and outcome(s).

If successful, my proposal can be used as an example to assist future faculty applications. This decision will not in any way influence the evaluation of my application. Click "Yes" to give permission. *

- ◉ Yes
- ○ No

III. Participant Biographies

Please compose your answers offline and copy/paste into the appropriate text boxes. While answers inputted into this form should be available if you close the form and return in the same browser, we cannot guarantee that this function will work.

Brief biography of faculty participant and explanation of how this project fits into their career trajectory. Note: applications from faculty at all career stages are encouraged. *

I am in my fourth year on the tenure-track at Gustavus and the Wind Rivers project I am planning this summer will put me in a strong position to build a new research project and write a National Science Foundation (NSF) proposal and an United States Geological Survey EDMAP proposal to acquire external funding.
Throughout my career I have investigated the thermal and deformational history of magmatic arc systems, which are regions where one tectonic plate sinking beneath another causes melting, magmatism, and volcanism. The aim of this work is to better understand the dynamic processes occurring in the crust of arc systems and the chemical differentiation processes occurring as the continental crust grows. I have conducted field-based geology projects in related settings with rock types, such as gneisses and granites, similar to what the Wind Rivers comprise. I delineated rock associations and fabrics during multiple field seasons in the Pioneer Mountains of Idaho, I spent two field seasons studying melt-present deformation in West Antarctica, and two field seasons investigating emplacement of igneous intrusions in the Klamath Mountains magmatic arc in northern California.
I see the Wind Rivers project as a natural progression of those three projects, in which I will use similar tools (e.g. field-based geologic mapping and structural analysis) to investigate a new region of the world. To achieve tenure at Gustavus and continue an active undergraduate-centered research program, I feel the Wind Rivers project is vital. The field-based research and subsequent analyses will open a broad and fruitful path of research for publications and forthcoming external grant proposals. I am certain the Wind Rivers project will be the cornerstone of future undergraduate research projects on samples we collect this summer, as well as field seasons during future summers.

Brief biography of student participant and explanation of how this project fits into their educational trajectory and their qualifications to engage in this project. Note: biography and explanation must be written by the student. *

I am hoping to conduct field work with Rory McFadden in the Wind River Range of Wyoming. The area has exposed Archean cratons that aid in our understanding of early tectonic activity in Earth's history. Completing field work and research on the Wind River Range will be an excellent opportunity for me to fulfill requirements for graduation, and will prepare me for my future as a graduate student and aspiring professor, by giving me research experience in another area of geology. As part of the geology major requirements, I have to write a senior thesis on my own research project, and since I have written a proposal for this research in Junior Seminar (GEO-392) this will be the perfect opportunity for me to achieve that. I have done research in the past with Laura Triplett on Seven Mile Creek, and Rory McFadden on the Pioneer Mountains, so I have experience working on research and finding ways to achieve the goals of that research. With the Seven Mile Creek project, I was able to study the effects of Best Management practices farmers are using in the area to determine which ones are the most effective in bettering water quality. With the Pioneer Mountains project, I studied rock and thin section samples for microstructural deformation in order to understand the larger context of deformation and metamorphism of the Pioneer Mountains. I'm hoping to study the petrology and structural geology of the Wind River Range in order to understand the field relationships of different units and the pressure/temperature conditions of the exposed Archean crust in the area. I have taken several classes that will help me achieve this including Earth Materials, Petrology, Structural geology, as well as Tectonics, a class I am currently taking.

IV. Project Information

Please compose your answers offline and copy/paste into the appropriate text boxes. While answers inputted into this form should be available if you close the form and return in the same browser, we cannot guarantee that this function will work.

A. Project description: Briefly describe the proposed project, its relationship to existing scholarship in the field, and the nature of the collaboration between faculty member and student. *

At convergent tectonic plate boundaries where two tectonic plate converge, the thinner, denser oceanic lithosphere subducts beneath the thicker, less dense continental lithosphere. In these regions, known as subduction zones, substantial thermal activity causes melting and the formation of a magmatic arc (Fig. 1). Volcanoes and mountains form the surface expression of magmatic arcs and igneous intrusions and partially melted continental crust form the plumbing system that redistributes heat and mass throughout the arc. Magmatic arcs are one of the prominent ways that new continental crust forms and undergoes differentiation (Clift and Vannucchi, 2004; Barth et al., 2013). These processes are a consequence of plate tectonics, but geoscientists are still not certain how early in earth history plate tectonics initiated (Dilek and Polat, 2008; Frost et al., 2006). Much debate has focused on the origins of plate tectonics and the timing of when plate tectonics began on earth (Brown et al., 2020, and references therein). To clarify the character of continental growth near the inception of plate tectonics and to assess large-scale dynamic processes such as subduction and mountain building, it is necessary to investigate the thermal and deformational history of magmatic arcs from early earth history, in the Archean Eon.

The purpose of this proposal is to investigate the structural and petrologic character of a fault zone within an Archean magmatic arc to clarify the thermal and deformational conditions during arc magmatism. The Mt Helen Structural belt, in the Wind River Range (WY), is a 3 km-wide fault zone that was actively deforming during the formation of an Archean magmatic arc (Frost et al., 2000). Igneous and metamorphic rocks within Wind River Range record evidence for one of the oldest (2.8 to 2.5 billion years old) magmatic arcs in the world (Frost et al., 2006) and the deformed rocks from within the Mt Helen Structural belt can be used to assess the thermal and deformational conditions. To provide new information on the inner workings of magmatic arc systems and constraints on the strength of rocks within magmatic arcs, this project will address two main questions: 1) What are the pressure and temperature conditions under which rocks within the Mt Helen Structural belt of the Wind River Range were deformed? 2) Based on strain and deformation analysis, what are the approximate strengths of rocks within the Mt Helen Structural belt?

The Wind River Range is part of the Wyoming Province, which is composed of Archean cratons with magmatic intrusions between 2.8–2.5 billion years ago (Fig. 2A) (Frost et al., 1998). The Wind River Range provides excellent exposures of Archean rocks in which to study tectonics during early earth history. These rocks preserve a range of intrusive events, indicative of a growing magmatic arc. The prominent rock types are granites, gneisses, and migmatites. These rocks are transected by the 3 km-wide Mt Helen Structural belt fault zone (Fig. 2B). The Mt Helen Structural belt contains deformed and foliated (layered) granites, gneisses, and migmatites, as well as discontinuous metamorphic rocks such as peridotite, granulite, and amphibolite, that are deformed and enveloped by the fault zone foliation (layering). These discontinuous metamorphic rocks range from 1–20 m in length (Frost et al., 2006) and they are at the heart of this project. To accurately determine the pressure and temperature conditions at which rocks equilibrated and to assess rock strength, geoscientists need rocks with appropriate mineral assemblages that also experienced deformation. Hannah Schroeder will map, sample, and analyze these discontinuous metamorphic rocks to determine the pressure and temperature conditions at which the Mt Helen Structural belt formed (Question #1). While Hannah is focused on the petrologic work, I will focus on constraining the strength of rocks within the Mt Helen Structural belt by collecting structural observations and samples for structural analysis to determine the geometry, structural character, and deformation conditions (Question #2). We will be collecting the petrologic and structural data together in the field and combining the datasets to tell a coherent tectonic story making this project a true collaboration.

References

Barth, A.P., Wooden, J.L., Jacobson, C.E., and Economos, R.C., 2013, Detrital zircon as a proxy for tracking the magmatic arc system: The California arc example, Geology, p. 223–226, doi:10.1130/G33619.1

Brown, M., Johnson, T., and Gardiner, N.J., 2020, Plate Tectonics and Archean Earth, Annual Reviews of Earth and Planetary Sciences, 48, p. 291–320, https://doi.org./101146/annurev-eart-081619-052705.

Clift, P., and Vannucchi, P., 2004, Controls on tectonic accretion versus erosion in subduction zones: Implications for the origin and recycling of the continental crust, Review in Geophysics, 42, RG2001, doi:10.1029/2003RG000127.

Dilek, Y., and Polat, A., 2008, Suprasubduction zones ophiolites and Archean tectonics, Geology, p. 431¬–432, doi:10.1130/Focus052008.1.

Frost, C.D., Frost, B.R., Chamberlain, K.R., and Hulsebosch, T.P., 1998, The Late Archean history of the Wyoming province as recorded by granitic magmatism in the Wind River Range, Wyoming: Precambrian Research, v. 89, p. 145-173.

Frost, B.R., Chamberlain, K.R., Swapp, S., Frost, C.D., and Hulsebosch, T.P., 2000, Late Archean structural and metamorphic history of the Wind River Range: Evidence for a long-lived active margin on the Archean Wyoming craton: GSA Bulletin, v. 112, n. 4, p. 564–578.

Frost, B.R., Frost, C.D., Cornia, M., Chamberlain, K.R., and Kirkwood, R., 2006, The Teton – Wind River domain: a 2.68-2.67 Ga active margin in the western Wyoming Province: Canadian Journal of Earth Sciences, v. 43, p. 1489–1510.

B. Project design: Please describe your project design and activities, including locations, staff, schedule of work, budget rationale, and anticipated project completion date. *

The Wind River Project consists of four parts (shown in the table below): 1) Preliminary work; 2) Field-based geologic mapping; 3) Sample analysis; and 4) Dissemination.

Project Timeline (likely starting in late June)
2 weeks – Preliminary work: Background reading, geologic map analysis, field work planning, route planning, sample collection strategies (McFadden and Schroeder)
3 weeks – Field-based geologic mapping in the Wind Rivers (McFadden, Schroeder, and Hentges (field assistant))
5 weeks – Sample Analysis: Rock preparation; Data analysis, creation of GIS-based geologic maps; EPMA analysis (McFadden and Schroeder)
Fall 2021 – Dissemination: Writing up of results for senior thesis and submission of external grant proposals (McFadden and Schroeder)

Preliminary work (June-July 2021)
During the first part of the Wind Rivers Project, Hannah and I will plan out the field logistics and sampling strategies for the field-based geologic mapping. We will study maps (topographic and geologic), plan hiking routes, camping locations, and learn the geologic units. Hannah will spend much of this time reading articles and creating preliminary digital geologic maps. There are some decent maps for the Wind Rivers, but few are digital or properly georeferenced. Before we conduct our field mapping, we need to make sure the maps we are using are accurate and up to date. Hannah is well-prepared to do this work because last summer she and I attended a short course on StraboSpot (https://strabospot.org/), a geologic mapping software application to create maps and collect field data.

Field-based geologic mapping (July-August 2021)
Hannah, a field assistant (Cora Hentges), and I will conduct 3 weeks of field-based geologic mapping to study the deformed gneisses, granites, and discontinuous metamorphic rocks of the Mt Helen Structural belt in the Wind River Range. We will create a detailed geologic map of a small area (2x5 km) and collect numerous rock samples across the Mt Helen Structural belt for further petrologic and structural analysis. The Mt Helen Structural belt is best exposed in a remote section of the Wind River Range near Indian Pass and Mt Jackson (NE of Pinedale, WY). We will backpack to access this area and backcountry camp for 4–5 days. This general field plan will allow us to do three trips of 4-5 days each for camping and geologic mapping. Thus, over the three weeks in the Wind River Range, we should get 12–15 days of field-based geologic mapping accomplished. Travel, lodging, and materials requested in this proposal all support the field component of this project. Please see the budget justification for a detailed description of each item. Additional funds for travel, lodging, and field assistant salary will be provided by McFadden startup funds.

Sample Analysis (August-September 2021)
Once we return from the Wind River Range, prepare rock samples, field data analysis, and geologic map creation. We will have thin sections of rock samples produced in a professional lab (e.g. Quality Thin Sections), but Hannah will cut the rock samples using a rock saw to create rock chips, which are properly oriented and selected based on the likely mineral assemblages and textures. While the rock thin sections are being prepared, we will analyze our field data and create a geologic map of the field area using GIS software. When the thin sections return (usually within three weeks), Hannah will determine the mineral assemblages using an optical microscope and select samples for quantitative thermobarometry (calculated temperatures and pressures) using the electron probe microanalyzer (EPMA). The EPMA is the standard tool for determining the quantitative elemental composition of minerals in rock samples. Hannah will use the EPMA at the University of Minnesota–Twin Cities to determine the chemical compositions of the relevant minerals. Following data collection, thermodynamic data on the minerals of interest will be used to calculate the pressures and temperatures at which the metamorphic rocks equilibrated. Focusing on large (1–20 m) discontinuous metamorphic rocks should provide insight into the temperature and pressure conditions of the Mt Helen Structural Belt. During this timeframe, and in collaboration with Hannah, I will be collecting strain measurements and conducting structural analysis on deformed minerals using the optical microscope. Results from the strain and structural analysis will be used to constrain the strength of rocks within the Mt Helen Structural Belt. Funds from McFadden startup will be used for professional thin sections and EPMA lab time.

Dissemination (Fall 2021)
During the fall semester, Hannah will write up her research results during the Geology Senior Seminar (GEO-393) and I will synthesize our work for grant proposals with the EDMAP project (November 2021) and the NSF Tectonics division (January 2022). I also expect Hannah and I to submit abstracts with presentations (oral or poster) to a regional Geological Society of America meeting (likely submission in December 2021).

C. Desired project outcomes: What are the anticipated outcomes for this project? Where do you anticipate publishing, presenting, exhibiting, or otherwise disseminating this project? *

The anticipated outcomes of this project include a well-constrained geologic map of a portion of the Mt Helen Structural belt, structural analysis of field-based measurements, and a suite of samples for in-depth petrologic and structural analysis. The geologic map and petrologic analysis will form the basis of Hannah's thesis. Our work will produce at least two meeting abstracts with presentations (oral or poster), an NSF grant proposal, and an EDMAP grant proposal. Hannah will likely present her senior thesis work at the regional Geological Society of America meeting in the spring 2022. She has research experience (see student biography) and I think presenting her work at a regional or national meeting will be an important next step for her because she is interested in graduate school and continuing in academia. I also will plan to present at the regional GSA meeting on the structural analysis of the Mt Helen Structural belt. The work on this grant will be an integral component of a National Science Foundation grant proposal submitted to Research at Undergraduate Institutions Tectonics Division (January 2022) and a grant proposal for further geologic mapping through the United States Geological Survey's EDMAP program (November 2021).

D. How will restrictions due to Covid-19 potentially affect your project? [This is not a criteria for selection of the grant.]

Potentially in significant ways if Gustavus continues a travel restriction on field-based research. If travel to field locations is still restricted, I would develop a complementary project for Hannah to work on. Of course, this would be far from ideal, but she is highly interested in petrology and tectonics research. If Covid does alter plans, I would be happy to a share an alternative project plan with the committee.

V. Budget

Download the Presidential Faculty/Student Collaboration budget form here: https://drive.google.com/file/d/1irwy0HSXSc7tZdiCOcvuDuo87JbgAGeS/view?usp=sharing. Then upload the completed budget form by clicking "Add File" below. *

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Provide a rationale/justification for your budget.

Equipment: None requested. Materials will be covered by McFadden and the geology department

Materials: Sample bags (for rocks) are important and a bit pricier than one would expect. The $40 covers a set of 25 10 x 17-inch sample bags. This is a reasonable estimate as to the number of samples Hannah will collect for her project. As a record of the field research, field notebooks are needed to record notes and measurements. Waterproof field notebooks, such as rite in the rain, cost $25. Having a waterproof field notebook is important when in the remote field.

Mileage: This proposal requests just under half of the projected travel costs. The staging area for field research in the Wind River Range will be Pinedale, WY. The roundtrip from Gustavus to Pinedale is approximately 2000 miles. Then, I expect an additional 100 miles of driving in and around the Wind River Range. At 2100 total miles, the travel will cost $1207.50. In this proposal, I am requesting, $575 for travel.

Lodging: Four nights of hotels at $90/night is requested for one room for Hannah and Cora (field assistant). Startup funds will cover a separate room for McFadden. Four nights will cover: 1 night in transit to Pinedale, 2 nights during the field season (end of week 1, end of week 2) for showers and resupply, and 1 night on the return trip to Gustavus.

Personnel: The work this summer on the Wind River project will be the main portion of Hannah's senior thesis and it will serve as the foundation for McFadden's future research projects. To complete an appropriate amount of work on this project, we are requesting the full 10 weeks of faculty stipend for McFadden and 400 hours of student stipend for Hannah. Please refer to the project timeline for our planned use of the 10 weeks (Project Outcomes section).

VI. Additional Information

Have you applied for funding from another source to support this project but do not yet know the outcome of that application? *

- ○ Yes
- ◉ No

If you replied "yes" to the previous question, please 1) indicate the funding source(s) and amount requested, 2) explain how the Presidential grant funds will be used in addition to the other funding if received, and 3) explain how the Presidential grant project would be impacted if external funding is not received.

Have you received funding from another source to support this project? *

- ◉ Yes
- ○ No

If you replied "yes" to the previous question, please 1) indicate the funding source(s) and amount requested, and 2) explain how the Presidential grant funds will be used in addition to the other funding received.

The academic year 2021-2022 will be the final year of my startup funds from Gustavus. I plan to use a substantial portion of these startup funds to support this summer research project. Startup funds will be used for travel, lodging, equipment, a field assistant, and research costs. The costs for the startup funds will be approximately $3,827.

Startup Budget for Wind Rivers Project

Travel: Gas for vehicle	$632
Lodging: 4 nights hotel $90/night	$360
Field Assistant: 120 hours at $13/hr	$1,560
Research: Polished rock thin sections 15 at $35/thin section	$525
Electron Probe Microanalyzer (EPMA)	$750
Total	$3,827

Travel: Travel costs for this field research to Pinedale, WY, will be split between startup funds and the Presidential grant. The startup funds will be used for just over half ($632) of the travel and the presidential grant would cover just under half ($575).

Lodging: Four nights of lodging ($360 total) for McFadden will be covered by the startup funds. The Presidential grant will cover shared hotel rooms for Hannah Schroeder (grantee) and Cora Hentges (field assistant).

Field Assistant: Field safety is paramount while doing remote field-based research. Due to this requirement, I plan to use my startup funds to support an additional Gustavus student, Cora Hentges (rising junior during summer 2021), as a field assistant for the three weeks of fieldwork ($13/hr for 120 hours; $1560). A second student is important for multiple reasons. Number one is field safety and student comfort in the remote field (backcountry) with a faculty member. Second, this experience will provide an excellent introduction to field-based geology research field for Cora. Third, having two students creates (limited) opportunities for independent fieldwork (without faculty member). A critical component of conducting research is independence and a field team with at least two students make this possible, even if only for a limited, well-constrained time.

Research Costs: Startup funds will also be used to cover the costs of using of polished rock thin sections and the electron probe microanalyzer (EPMA) at the University of Minnesota. I have budgeted for 15 rock thin sections ($35/section; $525 total) and one day ($750/day) of startup funds for Hannah to use the EPMA. The polished rock thin sections are necessary for petrologic analysis of the mineral assemblages and use on the EPMA. The University of Minnesota EPMA lab is an excellent facility in which Hannah will gain invaluable experience using a high-precision instrument to collect mineral chemistry data on the petrologic samples she will be studying. In the one day, she will collect sufficient data to constrain temperature and pressure conditions within the Mt Helen Structural belt.

Field Gear: Field research gear such as digital mapping devices (ipads) and backpacking gear (e.g. backpacks, tents) will be provided by the Geology department or McFadden's student gear. I and the geology department think it is important to provide (or be able to provide) all relevant field gear to support all students and make field-based research equitable and inclusive.

If you apply for and receive funding for both the Presidential Faculty-Student Collaboration grant and the Research, Scholarship, and Creativity grant, which will you accept? Grant guidelines specify recipients can only accept funding for one of the grants in a year.

- (●) Presidential Faculty-Student Collaboration grant
- ( ) Research, Scholarship, and Creativity grant

If there are any additional materials that you think would be helpful to the committee in deciding upon your application, please upload them here.

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If there are any additional materials that you think would be helpful to the committee in deciding upon your application (e.g. links to Google Drive files), please include URLs here.

VII. Applicants' Signature

Signature *

Rory McFadden