

Improving Undergraduate STEM Education: Pathways into Geoscience (IUSE: GEOPATHS)

PROGRAM SOLICITATION

NSF 18-583

REPLACES DOCUMENT(S):

NSF 17-574



National Science Foundation

Directorate for Geosciences
Division of Atmospheric and Geospace Sciences
Division of Earth Sciences
Division of Ocean Sciences
Office of Polar Programs

Directorate for Education & Human Resources
Division of Undergraduate Education
Division of Human Resource Development

Letter of Intent Due Date(s) (required) (due by 5 p.m. submitter's local time):

September 21, 2018

Full Proposal Deadline(s) (due by 5 p.m. submitter's local time):

November 19, 2018

IMPORTANT INFORMATION AND REVISION NOTES

A mentoring plan is now required for all student participants.

Any proposal submitted in response to this solicitation should be submitted in accordance with the revised *NSF Proposal & Award Policies & Procedures Guide* (PAPPG) ([NSF 19-1](#)), which is effective for proposals submitted, or due, on or after February 25, 2019.

SUMMARY OF PROGRAM REQUIREMENTS

General Information

Program Title:

Improving Undergraduate STEM Education: Pathways into the Earth, Ocean, Polar and Atmospheric & Geospace Sciences (IUSE:GEOPATHS) (GEOPATHS)

Synopsis of Program:

A well-prepared, innovative science, technology, engineering and mathematics (STEM) workforce is crucial to the Nation's health and economy. Indeed, recent policy actions and reports have drawn attention to the opportunities and challenges inherent in increasing the number of highly qualified STEM graduates, including STEM teachers. Priorities include educating students to be leaders and innovators in emerging and rapidly changing STEM fields as well as educating a scientifically literate populace. Both of these priorities depend on the nature and quality of the undergraduate education experience. In addressing these STEM challenges and priorities, the National Science Foundation invests in evidence-based and evidence-generating approaches to understanding STEM learning; to designing, testing, and studying instruction and curricular change; to wide dissemination and implementation of best practices; and to broadening participation of individuals and institutions in STEM fields. The goals of these investments include: increasing the number and diversity of STEM students; preparing students well to participate in science for tomorrow; and improving students' STEM learning outcomes.

NSF's *Improving Undergraduate STEM Education (IUSE)* initiative, launched in Fiscal Year 2014, supports a coherent set of investments to address immediate challenges and opportunities that are facing undergraduate STEM education, as well as those that anticipate new structures (e.g. organizational changes, new methods for certification or credentialing, course re-conception, cyberlearning, etc.) and new

functions of the undergraduate learning and teaching enterprise. The NSF-wide *IUSE* initiative acknowledges the variety of discipline-specific challenges and opportunities facing STEM faculty as they strive to incorporate results from educational research into classroom practice and work with education research colleagues and social science learning scholars to advance our understanding of effective teaching and learning.

The Directorate for Geosciences (GEO) contributes to the *IUSE* initiative through the *Improving Undergraduate STEM Education: Pathways into Geoscience (IUSE: GEOPATHS)* funding opportunity. *IUSE: GEOPATHS* invites proposals that specifically address the current needs and opportunities related to undergraduate education within the geosciences community. The primary goal of the *IUSE: GEOPATHS* funding opportunity is to increase the number of undergraduate students interested in pursuing undergraduate degrees and/or post-graduate degrees in geoscience through the design and testing of novel approaches for engaging students in authentic, career-relevant experiences in geoscience. In order to broaden participation in the geosciences, engaging undergraduate students from traditionally underrepresented groups or from non-geoscience degree programs is a priority. The *IUSE: GEOPATHS* solicitation features two funding tracks: (1) Engaging students in the geosciences through extra-curricular experiences and training activities (*GEOPATHS-EXTRA*), and (2) Improving pathways into the geosciences through institutional collaborations and transfer (*GEOPATHS-IMPACT*).

Cognizant Program Officer(s):

Please note that the following information is current at the time of publishing. See program website for any updates to the points of contact.

- M. Brandon Jones, telephone: (703) 292-4713, email: mbjones@nsf.gov
- Elizabeth L. Rom, GEO/OCE & GEO/PLR, telephone: (703) 292-7709, email: elrom@nsf.gov
- Amanda (Manda) S. Adams, GEO/AGS, telephone: (703) 292-8521, email: amadams@nsf.gov
- Aisha R. Morris, telephone: (703) 292-7081, email: armorris@nsf.gov

Applicable Catalog of Federal Domestic Assistance (CFDA) Number(s):

- 47.050 --- Geosciences
- 47.076 --- Education and Human Resources

Award Information

Anticipated Type of Award: Standard Grant or Continuing Grant

Estimated Number of Awards: 20

In FY 2019, NSF expects to make up to 20 awards through this competition, with ~10 awards being made in the GEOPATHS-EXTRA track and ~10 awards being made in the GEOPATHS-IMPACT track.

Anticipated Funding Amount: \$6,000,000

NSF anticipates available funding for the IUSE: GEOPATHS program to be approximately \$6 million total in FY 2019, subject to availability of funds.

Eligibility Information

Who May Submit Proposals:

Proposals may only be submitted by the following:

- Institutions of Higher Education (IHEs) - Two- and four-year IHEs (including community colleges) accredited in, and having a campus located in the US, acting on behalf of their faculty members. Special Instructions for International Branch Campuses of US IHEs: If the proposal includes funding to be provided to an international branch campus of a US institution of higher education (including through use of subawards and consultant arrangements), the proposer must explain the benefit(s) to the project of performance at the international branch campus, and justify why the project activities cannot be performed at the US campus.

Who May Serve as PI:

There are no restrictions or limits.

Limit on Number of Proposals per Organization:

An organization may serve as sole submitting institution or as lead institution of a collaborative project on only one submission per competition, regardless of track, but may serve as the non-lead institution of a collaborative project more than once per competition. Additional eligibility requirements are described later in the solicitation.

Potential PIs are advised to contact their institutional office of research regarding processes used to select proposals for submission.

Limit on Number of Proposals per PI or Co-PI:

A Principal Investigator may serve in the role of PI or Co-PI on only one proposal per competition if they are at the sole-submitting institution or the lead institution of a collaborative project, but may serve as the Co-PI for a non-lead institution of a collaborative project more than once per competition.

Proposal Preparation and Submission Instructions

A. Proposal Preparation Instructions

- **Letters of Intent:** Submission of Letters of Intent is required. Please see the full text of this solicitation for further information.
- **Preliminary Proposal Submission:** Not required
- **Full Proposals:**
 - Full Proposals submitted via FastLane: *NSF Proposal and Award Policies and Procedures Guide (PAPPG)* guidelines apply. The complete text of the PAPPG is available electronically on the NSF website at: https://www.nsf.gov/publications/pub_summ.jsp?ods_key=pappg.
 - Full Proposals submitted via Research.gov: *NSF Proposal and Award Policies and Procedures Guide (PAPPG)* guidelines apply. The complete text of the PAPPG is available electronically on the NSF website at: https://www.nsf.gov/publications/pub_summ.jsp?ods_key=pappg.
 - Full Proposals submitted via Grants.gov: *NSF Grants.gov Application Guide: A Guide for the Preparation and Submission of NSF Applications via Grants.gov* guidelines apply (Note: The *NSF Grants.gov Application Guide* is available on the Grants.gov website and on the NSF website at: https://www.nsf.gov/publications/pub_summ.jsp?ods_key=grantsgovguide).

B. Budgetary Information

- **Cost Sharing Requirements:**

Inclusion of voluntary committed cost sharing is prohibited.
- **Indirect Cost (F&A) Limitations:**

Not Applicable
- **Other Budgetary Limitations:**

Not Applicable

C. Due Dates

- **Letter of Intent Due Date(s) (required)** (due by 5 p.m. submitter's local time):

September 21, 2018
- **Full Proposal Deadline(s)** (due by 5 p.m. submitter's local time):

November 19, 2018

Proposal Review Information Criteria

Merit Review Criteria:

National Science Board approved criteria. Additional merit review considerations apply. Please see the full text of this solicitation for further information.

Award Administration Information

Award Conditions:

Additional award conditions apply. Please see the full text of this solicitation for further information.

Reporting Requirements:

Standard NSF reporting requirements apply.

TABLE OF CONTENTS

Summary of Program Requirements

- I. Introduction
- II. Program Description
- III. Award Information
- IV. Eligibility Information
- V. Proposal Preparation and Submission Instructions
 - A. Proposal Preparation Instructions
 - B. Budgetary Information
 - C. Due Dates

- D. [FastLane/Research.gov/Grants.gov](https://www.fastlane.gov/research/grants.gov) Requirements
- VI. **NSF Proposal Processing and Review Procedures**
 - A. Merit Review Principles and Criteria
 - B. Review and Selection Process
- VII. **Award Administration Information**
 - A. Notification of the Award
 - B. Award Conditions
 - C. Reporting Requirements
- VIII. **Agency Contacts**
- IX. **Other Information**

I. INTRODUCTION

Several recent reports developed by the National Science Board, the National Academies, and the President's Council of Advisors on Science and Technology (PCAST) have documented the substantial role played by the science, technology, engineering, and mathematics (STEM) disciplines as drivers of American innovation, prosperity, and global competitiveness (References 1 to 5). These reports have also noted that the "need for STEM knowledge extends to all Americans," due to the growing role of STEM products in the lives of citizens and the need of our democratic society to make informed decisions on the basis of scientific evidence. Yet, in spite of continually growing demand for STEM expertise and literacy, the United States is at risk of losing its competitive edge as fewer students pursue advanced degrees and careers in STEM disciplines and insufficient progress is made in engaging the full diversity of the Nation's potential talent pool in those fields. The decline in the number of students earning degrees in STEM fields is being compounded by the rapidly approaching retirement wave of the post-World War II cohort of scientists and engineers.

Recent reports on the *Status of the Geoscience Workforce 2016* report (References 6 & 7), published by the American Geosciences Institute (AGI), and related efforts to assess the educational and employment landscape within the geosciences (References 8 to 15), have documented clear evidence of this trend. Given Bureau of Labor Statistics estimates for the future geoscience workforce (growing at higher-than-average rates and projected turnover resulting from retirements), AGI predicts that production of new geoscientists at current rates will not be sufficient, resulting in a shortfall of ~90,000 geoscientists by the year 2024. The small number of students earning geoscience degrees (~380 associate's, ~3600 bachelor's, ~1500 master's, and ~600 doctoral) reveals the magnitude of the challenge facing the community in securing its future workforce.

With ~31,000 undergraduate students and ~10,000 graduate students enrolled in geoscience courses in 2013, there is potential to address some of the geoscience career shortfall through increased retention of students already in geoscience pathways. Improving efforts to retain individuals from groups who have traditionally been under-involved in the geosciences (i.e., individuals from groups currently earning only ~11% of the bachelor's, ~7% of master's, and <6% of doctoral degrees) is important since these students will soon be the majority of college age students in undergraduate programs.

Increasing the recruitment and retention of undergraduate students in geoscience courses might lead to more graduates in this discipline, however there are barriers that will need to be addressed. The geosciences differ from many other STEM disciplines in that there is not a well-defined pathway between high school, college education (both two-year and four-year), and graduate education or career options. AGI found that approximately half of the geoscientists surveyed – at all degree levels – had taken a formal Earth science course while in high school, demonstrating its importance for building the post-secondary pipeline. In fact, in 2017 69% of doctoral graduates in the geosciences reported taking a high school geoscience or environmental science course (Reference 24). High school exposure to the geosciences is an integral part of the recruitment pipeline for engaging students in geosciences pathways. Yet, fewer than 50% of high school graduates take a high school geoscience course (e.g., Earth science, oceanography, or meteorology) and the lack of an Advanced Placement course/exam in geoscience makes it difficult to elevate the reputation of the discipline and attract the most talented students. Given this lack of visibility in high school, geoscience continues to primarily be a discovery major at the undergraduate level, with a few notable exceptions (e.g., meteorology). Similarly, there is general lack of awareness about the many career opportunities available for students with degrees in the geosciences.

The increasing importance of community colleges in the higher education landscape (Reference 16) is similarly problematic for the geosciences community, given that only ~24% of the nearly 1725 two-year colleges (2YC's) nationwide offer a geoscience program or course. AGI reports that ~31% of geoscience bachelor's, 23% of master's and 8% of doctoral degree recipients spent at least one semester at a two-year institution before transferring to a four-year undergraduate program. The greater diversity of students found at community colleges offers an important, largely untapped opportunity for broadening participation in the geosciences. Degree program opportunities at many minority-serving institutions (MSI's), and especially at Historically Black Colleges and Universities (HBCU's), also are quite limited.

A strength of the geosciences is the fact that there are multiple entry points into the field, either as an undergraduate major or as a graduate student from other STEM fields such as chemistry, engineering, computer science, physics, biology, geography, or math. The interdisciplinary nature of the geosciences offers the potential for undertaking more innovative approaches to recruitment and retention of students. As defined by AGI, the "geosciences" are comprised of a variety of sub-fields, including traditional solid earth science (e.g., geology, geochemistry, geophysics), environmental earth science, atmospheric science, oceanography, and geo-related disciplines (e.g., hydrology), among others. Commonly, students who earn advanced degrees in geoscience fields began their path in a different STEM field as an undergraduate student. The increasing focus of geoscience work on societally relevant issues such as climate, natural hazards, energy resources, etc. also opens the door to engaging a variety of additional students, including those pursuing undergraduate degrees in the social sciences. The challenge, however, is to find effective strategies for opening the world of possibilities in the geosciences for these students and supporting them at the critical junctures where they might otherwise leave the pathway to geosciences.

Preparation of the future professional geoscience workforce is not just an issue of numbers. Of additional concern is what students should learn and experience as undergraduates, once they enter the pipeline. It is important to consider potential career pathways for geoscience students, as these inform the types of education required. AGI's workforce analysis has documented the rich suite of employment opportunities for students with geoscience degrees at all levels. Environmental Services (31%), federal government (24%), four-year (4yr) institution and construction (both 12%) are the top employment sectors for students with bachelor's degrees in geoscience, whereas master's students typically end up in oil and gas (60%), environmental services (16%), the federal government (12%), or at 4yr Institutions (8%). Implementation of the Next Generation Science Standards (NGSS; <http://www.nextgenscience.org/>), which elevate the role of earth and space science concepts in the high school curriculum, is expected to lead to increasing demand for geoscience educators, as well. The skills and competencies required to be successful in different geoscience career paths are not always identical. The recent "Summit on the Future of Undergraduate Geoscience Education" (<http://www.jsg.utexas.edu/events/future-of-geoscience-undergraduate-education/>) and related reports have begun to identify the skills, competencies, concepts and learning outcomes deemed essential for tomorrow's geoscience workforce. Critical thinking and problem-solving skills, spatial and temporal abilities, strong quantitative skills, and the ability to work in teams are among the priorities for many geoscience work environments.

To address these and related matters, the Directorate for Geosciences (GEO) is re-launching the *IUSE: GEOPATHS* program, to create and support innovative and inclusive projects to build the future geoscience workforce. This program is one component in the National Science Foundation (NSF) *Improving Undergraduate STEM Education (IUSE)* initiative, which is a comprehensive, Foundation-wide effort to enhance the quality and effectiveness of the education of undergraduates in all of the STEM fields. The importance of the undergraduate experience for preparing both a diverse STEM workforce ready and equipped for innovation, and a STEM-literate public ready to support and benefit from the progress of science, is described in several key reports and documents (e.g., References 2, 4, 19, 20 and 25). The *IUSE* Framework promotes new and exciting approaches to using research on STEM learning and education to address challenges across undergraduate STEM education, as well as within specific disciplines. The framework draws upon a knowledge base accumulated from decades of research, development, and best practices across the nation in STEM undergraduate education. NSF expects that investments within the *IUSE* portfolio will integrate theories and findings from education research with attention to the needs and directions of emerging science and engineering research directions. New knowledge about learning and implementation will be developed across all *IUSE* investments.

Building on the FY 2018 effort, *NSF-IUSE* continues to serve as the framework for all investments in research and development that are critical for curricular improvement in undergraduate STEM education, within formal and informal learning environments. FY 2019 *IUSE* programs call for proposals to:

- use and build evidence about improved STEM instructional practices;
- design and study innovative learning opportunities, including cyberlearning;
- create, implement, and test program, curricular, course, and technology-driven models;
- develop, implement, and test creative approaches for adoption of education research into disciplinary teachings;
- develop and validate assessments/metrics for undergraduate STEM learning and instructional practice; and,
- conduct foundational research on issues of undergraduate STEM teaching and learning.

The *IUSE* approach recognizes the dynamic and continually evolving landscape of individual STEM disciplines, the emerging interdisciplinary needs for undergraduate STEM learning, evolving challenges in the higher education domain, changing technologies, and the STEM needs of academia, government, and the private sector. The interplay between STEM education research and STEM education practice are featured; coupling between education research and education practice (e.g., References 17, 18) fosters a “cycle of innovation,” iterating between new questions emerging from innovative practice to be solved by new research and new solutions derived from research to be implemented through modified practice. Within and beyond specific STEM disciplines, new discoveries, new technologies, emergence of new sub-fields, and assimilation of interdisciplinary lines of inquiry create the context for needed change. Research and education synergies exist within undergraduate research experiences, research centers, and observing facilities, as well as classrooms. Ongoing changes in subject matter content, workforce needs, and theories of educational practice constitute the engine that drives new STEM education inquiry, development, testing, and implementation. Successful implementation along all stages of this cycle requires collaborations among STEM disciplinary experts, learning scientists, and STEM education practitioners.

Collectively, projects in the *IUSE* portfolio are intended to: improve STEM learning and learning environments, broaden participation and institutional capacity for STEM learning, and build the professional STEM workforce for tomorrow. Investments will include foundational and exploratory research, design and development research, and impact research. *IUSE: GEOPATHS* is not primarily about curricular improvement but relates to the *IUSE* goals of connecting education research to practice, building institutional capacity for preparing the professional geoscience workforce, and broadening participation in the geosciences. More information on the *IUSE* initiative is available in the core *IUSE* activity offered by the Education and Human Resources (EHR) directorate: the *EHR Improving Undergraduate STEM Education (IUSE: EHR)* program [https://www.nsf.gov/funding/pgm_summ.jsp?pims_id=505082].

II. PROGRAM DESCRIPTION

Improving Pathways into the Geosciences

The *IUSE: GEOPATHS* funding opportunity invites creative proposals to broaden and strengthen the pathways that will engage and retain diverse students in undergraduate and graduate geoscience degree programs and help them receive the necessary skills and competencies for a variety of careers pathways. *IUSE: GEOPATHS* projects are expected to utilize effective, evidence-based strategies for improving student engagement and retention, and to expose students to meaningful experiences in the geosciences through leveraging of academic and/or non-academic research and instrumentation infrastructure. The underlying hypothesis for this solicitation is that novel, authentic, career-relevant geoscience experiences for larger student populations not only augment existing curricula but will also increase the students’ desire to pursue degrees and geoscience-related careers.

The overarching questions being addressed through this solicitation are:

- Which strategies are most effective for increasing the number and diversity of students entering the geoscience workforce pipeline?
- Which approaches are most effective in retaining undergraduate students in the geoscience pipeline?
- Which activities are most effective in preparing undergraduate geoscience majors for the workforce, and smoothing their transition post-graduation?
- Which strategies are most effective for increasing the number and diversity of non-geoscience undergraduate majors that pursue post-baccalaureate degrees in geoscience?

IUSE: GEOPATHS projects also offer an opportunity to tap the nation’s diverse student talent pool and broaden participation in science and engineering. NSF is particularly interested in increasing the numbers of women, underrepresented minorities, and persons with disabilities in professional experiences related to the geosciences. *IUSE: GEOPATHS* projects are strongly encouraged to involve students who are members of these groups that are underrepresented in STEM: African Americans, Hispanics, American Indians, Alaska Natives, and Native Hawaiians or other Pacific Islanders. When designing recruitment plans, *IUSE: GEOPATHS* projects are also encouraged to consider students who are veterans of the U.S. Armed Services.

The *IUSE: GEOPATHS* solicitation offers two distinct funding Tracks: (1) Engaging students in the geosciences through extra-curricular experiences and training (*GEOPATHS-EXTRA*) and (2) Improving pathways into the geosciences through institutional collaborations (*GEOPATHS-IMPACT*).

GEOPATHS-EXTRA Projects

GEOPATHS-EXTRA projects are focused on providing individual undergraduate students with sustained or catalytic experiences that develop their expertise in geoscience, enhance their professional skills, increase their access to professional networks, and demonstrably deepen their interest in, and knowledge of, geoscience career pathways. Introducing students to the geosciences through extra-curricular experiential learning, internships, field trips, and culturally-relevant or problem-based learning scenarios, are well-documented as successful approaches for recruitment. More than a decade of empirical research has demonstrated the benefits to students from participating in undergraduate research because it not only socializes undergraduates into scientific thinking and

practices, it may also play a significant role in students' educational and career trajectories, especially among Hispanic/Latino students (e.g., References 19 to 23). AGI reports that more than 80% of bachelor's and master's graduates in the geosciences who participated in some form of internship during their education felt it was very important for their academic and professional development; yet, less than half of undergraduate geoscience majors participated in an internship-like experience. Increasing the number and types of opportunities that provide individual undergraduate students with authentic, career-relevant experiences – across all employment sectors – may increase both student engagement and retention in the pipeline. Many academic, private sector and government-managed facilities within the geosciences community could be leveraged to provide such experiences.

GEOPATHS-EXTRA proposals can be submitted by institutions of higher education that offer undergraduate courses or bachelor's degrees in any of the geoscience fields, with some restrictions (see eligibility criteria). *GEOPATHS-EXTRA* projects are expected to focus on the needs of individual students, primarily by offering cohort-based, extra- or co-curricular experiences that complement the submitting institution's existing bachelor's degree curriculum. Each cohort should involve a minimum of six students per institution. Collaborations with other academic and non-academic institutions that create opportunities to expose participating students to a variety of working environments are strongly encouraged, as are collaborations that engage diverse undergraduate students from local community colleges and MSIs. While requests to support academic year undergraduate research as one component of a *GEOPATHS-EXTRA* project will be considered, they must not duplicate the types of undergraduate research experiences that can be supported through the REU Site and Supplement program solicitation.

Specific activities that might be supported through the *GEOPATHS-EXTRA* track include, but are not limited to, the following:

- Creating mentored geoscience-related internships, externships, or apprenticeship programs in collaboration with the private sector
- Providing students with service-learning or community-based opportunities related to the geosciences
- Establishing and conducting novel support programs aimed at retaining diverse students in geosciences
- Partnering with large research facilities, to provide students with hands-on training and experience using sophisticated geoscience instrumentation, large data sets, and/or models
- Engaging students in large, ongoing, and separately funded field-based research campaigns and subsequent data analysis and synthesis
- Creating competitions and prizes that offer capstone experiences at large or unique geoscience research facilities
- Engaging pre-service science teachers in activities that foster their interest in becoming secondary earth science teachers
- Providing experiences that help pre-college students transition more successfully into undergraduate geoscience programs
- Establishing new multi-year, academic-year geoscience research opportunities for cohorts of undergraduate students at the awardee institution
- Offering accessible field experiences for students with sensory, physical, or intellectual disabilities; this includes intentional engagement of students with "less apparent" disabilities, high functioning undergraduate students on the autism spectrum and students in STEP-like transition programs (Reference 25).

Proposals submitted to this track should build on the evidence base for effective strategies for undergraduate engagement, recruitment and retention, particularly among underrepresented student populations. Similarly, they should be designed to contribute to the evidence base through formative and summative assessment and documenting the impacts of the experiences on student attitudes, learning outcomes, and persistence in the pipeline. Competitive proposals will clearly articulate how the proposed activities scaffold to, and integrate with, the academic program(s); carefully describe methods for recruitment and selection of students; and, discuss professional development activities that better prepare faculty and other professional participants for their roles as mentors/supervisors.

GEOPATHS-IMPACT Projects

GEOPATHS-IMPACT projects are expected to establish new, or strengthen existing, institutional partnerships and collaborations that provide sustainable pathways and support mechanisms for facilitating transitions of undergraduate students at critical junctions: between high school and undergraduate geoscience programs; between two-year undergraduate institutions and four-year institution geoscience degree programs; between baccalaureate degrees in geoscience and the geoscience workforce; or, between baccalaureate degrees (in any field) and post-baccalaureate geoscience programs. *GEOPATHS-IMPACT* projects are expected to focus less on the engagement of individual students in the geosciences and focus more on implementing systemic and sustainable approaches that can increase access to geoscience education and research opportunities and open doors to education and career pathways over time. The emphasis is on using NSF funding to establish programs, structures, and collaborations that can have lasting impact. For example, formal articulation agreements, e.g., between four-year and two-year institutions, can ease student transfers into geoscience bachelor's degree programs. Education and research collaborations between institutions may also help first and second year students, who might otherwise not encounter geoscience before deciding on a major, explore the possibilities within the field. Providing reliable and current information about career paths and opportunities, as well as sustained mentoring, networking, and professional development are also important strategies in helping students make the transition from undergraduate to graduate study and beyond. In addition, proposers seeking to develop institutional collaborations between two-year colleges and four-year programs that involve geoscience technician training are directed to NSF's Advanced Technological Education (ATE) program.

Specific activities that might be supported through the *GEOPATHS-IMPACT* track include, but are not limited to, the following:

- Cross-listing and/or co-teaching introductory geosciences classes between 2-year and 4 year institutions
- Convening small workshops or strategic planning activities to establish new institutional collaborations
- Designing and testing novel bridge programs that help post-undergraduate students from non-geoscience fields transition into geoscience graduate programs
- Formalizing collaborations between geoscience departments and education schools that strengthen the preparation of pre-service geoscience teachers
- Conducting novel outreach programs aimed at recruiting more diverse students into undergraduate and graduate geoscience pathways
- Creating mechanisms to engage upper level high school or community college students in experiences that demonstrate the geosciences as a viable career path before applying for college admission or transfer to a 4-year program
- Creating summer bridge programs that expose incoming undergraduate freshmen to the geosciences
- Leveraging large research infrastructure (e.g., ships, Critical Zone Observatories) to expose non-geoscience and pre-service teacher majors to geoscience content and opportunities
- Creation of enrichment programs that develop undergraduate skills required by the evolving job market for geoscientists and increase their matriculation into jobs classified as geoscience
- Developing career-aligned collaborations between academia and the local private sector or state/local government that facilitate transitions between undergraduate programs and the geoscience workforce
- Creating mechanisms to engage students with sensory, physical, or intellectual disabilities, including "less apparent" disabilities in accessible field and research experiences;

Proposers seeking to engage students at two-year institutions through this track are reminded of some of the specific barriers to attainment that these students must confront (e.g., References 16, 21, 22). These include: limited knowledge about college navigation; financial concerns; insufficient academic preparation, especially in math; misalignment of core courses across community colleges and four-year schools; limited advising, orientation, and mentoring; constraints affecting the academic and social integration of working students; and lack of self-efficacy.

Competitive proposals submitted to the *GEOPATHS-IMPACT* track will show evidence that all institutional partners are committed to and have been engaged intellectually in the design and execution of the proposed work. It is also important that proposals not only include details on the transition that the project would enhance, but also demonstrate that the infrastructure is in place to foster the success of students once they transition to the new academic stage. A management plan, a sustainability plan, and a plan for tracking students should be described. Proposals seeking funds to support an existing institutional collaboration must clearly demonstrate the effectiveness of current activities being implemented through the partnership and identify the gaps that would be addressed if additional resources were made available.

Important Note: Proposals seeking to support student transitions between Tribal Colleges and four-year geoscience degree programs should be submitted through the *Tribal Colleges and Universities Program (TCUP) Partnerships for Geoscience Education (PAGE)* track (see https://www.nsf.gov/funding/pgm_summ.jsp?pims_id=5483).

REFERENCES

1. National Research Council (2010) *Rising Above the Gathering Storm, Revisited: Rapidly Approaching Category 5*. Washington, DC: National Academies Press, www.nap.edu/catalog.php?record_id=12999.
2. National Research Council (2011) *Expanding Underrepresented Minority Participation: America's Science and Technology Talent at the Crossroads*. Washington, DC: National Academies Press, www.nap.edu/catalog.php?record_id=12984.
3. President's Council of Advisors on Science and Technology (2012) *Engage to Excel: Producing One Million Additional College Graduates with Degrees in Science, Technology, Engineering, and Mathematics*, https://obamawhitehouse.archives.gov/sites/default/files/microsites/ostp/pcast-engage-to-excel-final_feb.pdf.
4. National Research Council (2012) *Discipline-based Education Research: Understanding and Improving Learning in Undergraduate Science and Engineering*. Washington, DC: National Academies Press, www.nap.edu/catalog.php?record_id=13362.
5. National Science and Technology Council, Committee on STEM Education (2013) *Federal Science, Technology, Engineering, and Mathematics (STEM) Education 5-Year Strategic Plan*, https://obamawhitehouse.archives.gov/sites/default/files/microsites/ostp/stem_stratplan_2013.pdf.
6. Zeigler, K., S.A. Camarota (2014) *Is there a STEM worker shortage? A look at employment and wages in science, technology, engineering, and math*, Center for Immigration Studies, <http://cis.org/no-stem-shortage>.
7. Wilson, C. (2016) *Status of the Geoscience Workforce 2016*, American Geosciences Institute, www.americangeosciences.org/workforce.
8. *Emerging Workforce Trends in the U.S. Energy and Mining Industries: A Call to Action* (2013), National Academy of Science Board on Earth Sciences and Resources, <http://dels.nas.edu/Report/Report/18250>.
9. *Preparing the Next Generation of Earth Scientists: An Examination of Federal Education and Training Programs* (2013) National Academy of Science Board on Earth Sciences and Resources, <http://dels.nas.edu/Report/Preparing-Next-Generation-Earth/18369>.
10. Mascarelli, A. (2013) *Sustainability: Environmental puzzle solvers*, *Nature* 494, 507-509. doi:10.1038/nj7438-507a. Published online February 27, 2013.
11. Perkins, Sid (2011) *Geosciences: Earth works*, *Nature* 473, 243-244. doi:10.1038/nj7346-243a. Published online May 11, 2011.
12. *Issues Affecting the Future of the U.S. Space Science and Engineering Workforce: Interim Report* (2006) http://www.nap.edu/catalog.php?record_id=11642.
13. National Oceanic and Atmospheric Administration *Strategic Human Capital Management Plan: Developing, Valuing, and Sustaining a World-Class Workforce FY 2006-FY 2011*, http://www.wfm.noaa.gov/pdfs/Strategic_Human_Capital_Management_Plan.pdf.
14. *Educational Competencies for Marine Science and Technology Occupations*. Marine Advanced Technology Education Center, Monterey, CA, 55 pp.; *Geospatial Workforce Development White Paper* (2012) National Geospatial Advisory Committee (NGAC) <http://www.fgdc.gov/ngac/ngac-geospatial-workforce-development-paper-final.pdf>.
15. Workshop on "Geoscience and the 21st Century Workforce" (2013) Convened by InTeGrate, AGI, and AWG, <http://serc.carleton.edu/integrate/workshops/workforce2013/index.html>.
16. National Academy of Engineering and National Research Council report, "Community Colleges in the Evolving STEM Education Landscape: Summary of a Summit" (2102) Washington, DC: The National Academies Press.
17. Booth, W.C., G.C. Colomb and J.M. Williams (2008) *The Craft of Research*, 3rd edition, Chicago: University of Chicago Press.
18. American Society for Engineering Education (2009) *Creating a culture for scholarly and systematic innovation in engineering education*. Washington, DC: ASEE.
19. Thiry, H., T.J. Weston, S.L. Laursen, and A.B. Hunter (2012) *The benefits of multi-year research experiences: Differences in novice and experienced students' reported gains from undergraduate research*, *CBE Life Sciences Education*, 11 (Fall), 260-272.
20. Russell, S.H., M.P. Hancock, and J. McCullough (2007) *Benefits of undergraduate research experiences*, *Science*, 316, 548-549.
21. Hurtado, S., C.B. Newman, M.C. Tran, and M.J. Chang (2010) *Improving the rate of success for underrepresented racial minorities in STEM fields: Insights from a national project*, *New Directions for Institutional Research*, Volume 148, 5-15.
22. Chang, M.J., J. Sharkness, S. Hurtado, and C.B. Newman (2014), *What matters in college for retaining aspiring scientists and engineers from underrepresented racial groups*, *Journal of Research in Science Teaching*, volume 51 (5), 555-580.
23. National Academies of Sciences, Engineering and Medicine, *Service-Learning in Undergraduate Geosciences: Proceedings of a Workshop* (2017). Washington, DC: National Academies Press, <https://www.nap.edu/download/24621>
24. Wilson, C. (2016) *Status of Recent Geoscience Graduates*, American Geosciences Institute, https://www.americangeosciences.org/sites/default/files/ExitSurvey_2017_Online_041018.pdf
25. Atchison, C.L. and B.H. Gilley (2015) *Geology for everyone: making the field accessible*, *Earth Magazine*, <https://www.earthmagazine.org/article/geology-everyone-making-field-accessible>

III. AWARD INFORMATION

Regardless of which track is selected, the program expects to offer approximately 20 awards, with the average total award size expected to be in the \$300,000 to \$350,000 range. The duration of awards for both tracks will be up to 36 months. Estimated program budget, number of awards and average award size/duration are subject to the availability of funds.

IV. ELIGIBILITY INFORMATION

Who May Submit Proposals:

Proposals may only be submitted by the following:

- Institutions of Higher Education (IHEs) - Two- and four-year IHEs (including community colleges) accredited in, and having a campus located in the US, acting on behalf of their faculty members. Special Instructions for International Branch Campuses of US IHEs: If the proposal includes funding to be provided to an international branch campus of a US institution of higher education (including through use of subawards and consultant arrangements), the proposer must explain the benefit(s) to the project of performance at the international branch campus, and justify why the project activities cannot be performed at the US campus.

Who May Serve as PI:

There are no restrictions or limits.

Limit on Number of Proposals per Organization:

An organization may serve as sole submitting institution or as lead institution of a collaborative project on only one submission per competition, regardless of track, but may serve as the non-lead institution of a collaborative project more than once per competition. Additional eligibility requirements are described later in the solicitation.

Potential PIs are advised to contact their institutional office of research regarding processes used to select proposals for submission.

Limit on Number of Proposals per PI or Co-PI:

A Principal Investigator may serve in the role of PI or Co-PI on only one proposal per competition if they are at the sole-submitting institution or the lead institution of a collaborative project, but may serve as the Co-PI for a non-lead institution of a collaborative project more than once per competition.

Additional Eligibility Info:

The limitation on eligible organizations noted above applies only to sole submitting institutions or lead institutions of a collaborative proposal. All other eligible institutions identified in the PAPPG are eligible to participate as the non-lead institution of a collaborative proposal. In addition, the following eligibility limitations apply:

GEOPATHS-EXTRA proposals: NSF is restricting the eligibility of institutions that may serve as the sole submitting organization or the lead institution in a collaborative proposal in order to increase opportunities for smaller and/or primarily undergraduate institutions that have less access to significant Federal funding for STEM research and related infrastructure. Institutions of higher education (as defined in section 101 (a) of the Higher Education Act of 1965) in the United States and its territories that grant associate, baccalaureate, or graduate degrees in the disciplines listed in the [National Center for Education Statistics' Classification of Instructional Programs](#) database are eligible to submit proposals, with the following restrictions. Institutions identified by the Carnegie Classifications in effect at the time of this solicitation as "R1: Doctoral Universities, (highest research activity)" may not serve as the lead institution and may only submit proposals as the non-lead institution of a collaborative **GEOPATHS-EXTRA** proposal. A list of the non-eligible R1, highest research institutions is available at: http://carnegieclassifications.iu.edu/classification_descriptions/basic.php.

GEOPATHS-IMPACT proposals: Institutions of higher education (as defined in section 101 (a) of the Higher Education Act of 1965) in the United States and its territories that grant associate, baccalaureate, or graduate degrees in the disciplines listed in the [National Center for Education Statistics' Classification of Instructional Programs](#) database are eligible to submit proposals as the sole submitting organization or lead institution in a collaborative proposal, with no restrictions on institution type.

V. PROPOSAL PREPARATION AND SUBMISSION INSTRUCTIONS

A. Proposal Preparation Instructions

Letters of Intent (required):

Letters of Intent (submitted through FastLane) are required for both tracks. Any full proposals received for projects that did not submit a Letter of Intent by the required deadline will be returned without review. The Letter of Intent should identify the track to which the proposal is being submitted to and the name and institutions of the PI, Co-PIs and other key personnel who will be involved with the project. If the project will be leveraging a named research facility or program (e.g., NCAR, EarthScope, LSAMP), this facility/program should be identified. The Letter of Intent should also identify which geoscience sub-fields (e.g., oceanography) or employment sectors (e.g., mining) are being addressed, if relevant. A brief synopsis (**less than 2,500 characters**) of the project design and activities to be undertaken should be provided. If more than one Letter of Intent is received from an institution in which they are the lead of a collaborative project, they will be asked to make a decision as to which proposal will move forward. Letters of Intent are not binding but are used by NSF program staff to gauge the number of proposals likely to be submitted and to identify the types of reviewer expertise that will be required.

Letter of Intent Preparation Instructions:

When submitting a Letter of Intent through FastLane in response to this Program Solicitation please note the conditions outlined below:

- Submission by an Authorized Organizational Representative (AOR) is required when submitting Letters of Intent.
- A Minimum of 0 and Maximum of 4 Other Senior Project Personnel are permitted
- A Minimum of 0 and Maximum of 5 Other Participating Organizations are permitted
- Submission of multiple Letters of Intent is permitted

Full Proposal Preparation Instructions: Proposers may opt to submit proposals in response to this Program Solicitation via FastLane, Research.gov, or Grants.gov.

- Full proposals submitted via FastLane: Proposals submitted in response to this program solicitation should be prepared and submitted in accordance with the general guidelines contained in the *NSF Proposal & Award Policies & Procedures Guide* (PAPPG). The complete text of the PAPPG is available electronically on the NSF website at: https://www.nsf.gov/publications/pub_summ.jsp?ods_key=pappg. Paper copies of the PAPPG may be obtained from the NSF Publications Clearinghouse, telephone (703) 292-8134 or by e-mail from nsfpubs@nsf.gov. Proposers are reminded to identify this program solicitation number in the program solicitation block on the NSF Cover Sheet For Proposal to the National Science Foundation. Compliance with this requirement is critical to determining the relevant proposal processing guidelines. Failure to submit this information may delay processing.
- Full Proposals submitted via Research.gov: Proposals submitted in response to this program solicitation should be prepared and submitted in accordance with the general guidelines contained in the *NSF Proposal and Award Policies and Procedures Guide* (PAPPG). The complete text of the PAPPG is available electronically on the NSF website at: https://www.nsf.gov/publications/pub_summ.jsp?ods_key=pappg. Paper copies of the PAPPG may be obtained from the NSF Publications Clearinghouse, telephone (703) 292-8134 or by e-mail from nsfpubs@nsf.gov. The Prepare New Proposal setup will prompt you for the program solicitation number.
- Full proposals submitted via Grants.gov: Proposals submitted in response to this program solicitation via Grants.gov should be prepared and submitted in accordance with the *NSF Grants.gov Application Guide: A Guide for the Preparation and Submission of NSF Applications via Grants.gov*. The complete text of the *NSF Grants.gov Application Guide* is available on the Grants.gov website and on the NSF website at: (https://www.nsf.gov/publications/pub_summ.jsp?ods_key=grantsgovguide). To obtain copies of the Application Guide and Application Forms Package, click on the Apply tab on the Grants.gov site, then click on the Apply Step 1: Download a Grant Application Package and Application Instructions link and enter the funding opportunity number, (the program solicitation number without the NSF prefix) and press the Download Package button. Paper copies of the Grants.gov Application Guide also may be obtained from the NSF Publications Clearinghouse, telephone (703) 292-8134 or by e-mail from nsfpubs@nsf.gov.

In determining which method to utilize in the electronic preparation and submission of the proposal, please note the following:

Collaborative Proposals. All collaborative proposals submitted as separate submissions from multiple organizations must be submitted via the NSF FastLane system. PAPPG Chapter II.D.3 provides additional information on collaborative proposals.

See PAPPG Chapter II.C.2 for guidance on the required sections of a full research proposal submitted to NSF. Please note that the proposal preparation instructions provided in this program solicitation may deviate from the PAPPG instructions.

The following requirements generally apply to both tracks. Specific requirements that are unique to one of the tracks are clearly identified.

Proposal Title: The proposal title established in FastLane should clearly indicate which track is being supported by the proposed project, using the relevant format here:

For **GEOPATHS: EXTRA** projects, the title should read as “**GP-EXTRA:** rest of the title....”

For **GEOPATHS: IMPACT** projects, the title should read as “**GP-IMPACT:** rest of the title....”

Project Description:

- a. *Overview.* Provide a brief description of the goals and objectives of the proposed *IUSE: GEOPATHS* project, the intellectual focus, organizational structure, timetable, and any participating organizations' commitment to the activity. Information should be provided about the specific student population being targeted (e.g., demographics, grade level, critical juncture), as well as a justification as to why this particular population was chosen.
- b. *Institutional Profile(s).* Provide a brief description of the submitting organization and any other institutional partners in the project. Proposals should describe the current status of undergraduate geoscience education, research, and/or training opportunities at each institution, including the demographics and expertise of the faculty, staff, and the number, demographics, and expertise of the undergraduate or other targeted student population participating in these geoscience opportunities. If more than one institution is involved in the project, the proposal should describe the goals of the collaboration and the anticipated outcomes for students who will benefit from that collaboration. The roles of each institution and a management plan should be clearly defined.
- c. *Project Design.* Proposals should describe the specific activities that will be undertaken to achieve the goals outlined in this solicitation, appropriate for the specific track being addressed.

For **GEOPATHS-EXTRA** projects, this section should address the approach to undergraduate research, training, or other extracurricular activities being taken, as well as provide detailed descriptions of extracurricular projects and activities that students will pursue. A discussion of how the proposed activities scaffold to the formal instructional curriculum at the submitting institution must be included. The evidence base that underpins the specific project design being proposed, the significance of the research/training area, and, when appropriate, the underlying theoretical framework, hypotheses, research questions, etc. of any scientific research activities that will be undertaken by students should be discussed and will be used by reviewers to evaluate the intellectual merit. Prior research has shown that undergraduate research and training experiences have their greatest impact in situations that lead the participants from a relatively dependent status to an independent status as their competence warrants. Development of career-relevant competencies and skills in participating students should be a goal of the intervention(s). Proposals must present plans that will ensure the development of student-faculty and student-professional interactions, as well as student-student communication. Mentoring, professional socialization, development of collegial relationships and interactions, and cultivation of other 21st century workforce skills should be important parts of the project.

For **GEOPATHS-IMPACT** projects, this section should describe the goals of the partnership, the rationale for why specific partners have been chosen, the nature of the activities that will be undertaken through the partnership, and the anticipated outcomes of these activities for the participating students, geoscience professionals, and collaborating institutions. A detailed implementation plan should be provided. The number and demographics of students participating in or affected by these activities should be described. This section should also consider strategies for documenting the impact of the proposed activities on student engagement and attainment in the geosciences and whether the anticipated project outcomes have been achieved. So that reviewers can evaluate the intellectual merit, this discussion should indicate the evidence base that underpins the specific project design being proposed and a rationale for why specific partners have been recruited to participate. This section should also describe the potential for sustainability of the NSF-initiated activities once the grant has ended.

- d. *Project Personnel.* This subsection should describe any relevant experience and the record of involvement with undergraduate research, training, and/or education of the PI, the faculty or other professionals who may serve as mentors for the proposed activities. The description should include information on the record of faculty/mentors in publishing work involving undergraduate authors and/or in providing professional development opportunities for student researchers/trainees. For all **GEOPATHS-EXTRA** projects and relevant **GEOPATHS-IMPACT** projects, this section should

- also discuss the diversity of the mentor pool; strategies for recruiting and selecting additional mentors; any training, mentoring, or monitoring that mentors have received or will receive to help them mentor students effectively during the extra- or co-curricular experience; and any plans by which mentoring relationships will be sustained after students leave the *IUSE: GEOPATHS*-supported activity.
- e. *Student Recruitment and Selection*. The overall quality of the student recruitment and selection processes and criteria will be an important element in the evaluation of *IUSE: GEOPATHS* proposals. This criterion is most relevant for **GEOPATHS-EXTRA** projects, but will also be important for **GEOPATHS-IMPACT** projects that are designed to engage individual undergraduate students in specific activities. The student recruitment plan should be described with as much specificity as possible, including the types and/or names of academic institutions or other partners where students will be recruited and the efforts that will be made to attract members of underrepresented groups (women, minorities, and persons with disabilities). The names of any ongoing programs to engage underrepresented minorities in STEM disciplines (e.g., LSAMP, SOARS) that may be leveraged for recruitment should be identified. The number of participants engaged in *GEOPATHS* activities should be appropriate to the institutional or organizational setting, as well as the project design.
 - f. *Project Evaluation and Reporting*. NSF will be contracting with a third party to assist with program-level monitoring of the portfolio of awards made through the *IUSE: GEOPATHS* competition. However, each project should include a description of formative and summative evaluation activities that will be undertaken to improve implementation and document progress toward achieving major goals and objectives. This section should describe efforts to measure qualitatively and quantitatively the success of the project in achieving its goals, particularly with regard to the degree to which students have gained geoscience content knowledge and skills, have changed their perspectives and attitudes toward geoscience education and career paths, and/or have been successfully retained at critical junctures in the pathway. Evaluation may involve periodic measures throughout the project to ensure that it is progressing satisfactorily according to the project plan, and may involve pre-project and post-project measures aimed at determining the degree of student learning that has been achieved. In addition, it is highly desirable to have a structured means of tracking participating students beyond graduation, with the aim of gauging the degree to which the *IUSE: GEOPATHS* experience has been a lasting influence in the students' career paths. Proposers may wish to consult *The 2010 User-Friendly Handbook for Project Evaluation* (<http://www.westat.com/sites/westat.com/files/2010UFHB.pdf>) for guidance on the elements in a good evaluation plan. Depending on the nature of the proposed effort, PIs may wish to engage specialists in program evaluation (from their organization or another one) in planning and implementing the project evaluation.
 - g. *Sustainability Plan*. The proposal should describe plans for sustaining programs, activities and/or collaborations that have been developed through the project once NSF funding has ended. If the sustainability plan involves continuing institutional support, a letter of commitment from senior administration official(s) confirming that support should be included in the Supporting Documents section of the proposal.

B. Budgetary Information

Cost Sharing:

Inclusion of voluntary committed cost sharing is prohibited.

Budget Preparation Instructions:

It is expected that most of the funding being requested will be used to support undergraduate student participation or programs/mechanism/experiences that would directly impact undergraduate students. Proposers should consult with their Sponsored Research Office as to whether institutional policies require that this support be in the form of *Participant Support Costs* or through some other budget category (e.g., Salaries). The institution must make the determination whether the undergraduate student is considered an employee or a research participant. A student employee is compensated for services rendered and should be included in the salary section of the budget. Participants serve a different role on the project because their involvement is aimed at developing the students' research skills, or providing the student with a practical educational experience. Undergraduate students supported directly with NSF funds (through stipends or salary from an *IUSE: GEOPATHS* award) must be U.S. citizens, U.S. nationals, or permanent residents of the United States.

The PI is expected to attend a meeting of *IUSE: GEOPATHS* Principal Investigators during the first year of the project, likely to be held in the Washington, DC metro area, or an alternative location (e.g., professional society meeting), and should include funding to support travel and per diem for this two-day meeting in the budget.

C. Due Dates

- **Letter of Intent Due Date(s) (required)** (due by 5 p.m. submitter's local time):
September 21, 2018
- **Full Proposal Deadline(s)** (due by 5 p.m. submitter's local time):
November 19, 2018

D. FastLane/Research.gov/Grants.gov Requirements

For Proposals Submitted Via FastLane or Research.gov:

To prepare and submit a proposal via FastLane, see detailed technical instructions available at: <https://www.fastlane.nsf.gov/a1/newstan.htm>. To prepare and submit a proposal via Research.gov, see detailed technical instructions available at: https://www.research.gov/research-portal/appmanager/base/desktop?_nfpb=true&_pageLabel=research_node_display&_nodePath=/researchGov/Service/Desktop/ProposalPreparationandSubmission.html. For FastLane or Research.gov user support, call the FastLane and Research.gov Help Desk at 1-800-673-6188 or e-mail fastlane@nsf.gov or rgov@nsf.gov. The FastLane and Research.gov Help Desk answers general technical questions related to the use of the FastLane and Research.gov systems. Specific questions related to this program solicitation should be referred to the NSF program staff contact(s) listed in Section VIII of this funding opportunity.

For Proposals Submitted Via Grants.gov:

Before using Grants.gov for the first time, each organization must register to create an institutional profile. Once registered, the applicant's organization can then apply for any federal grant on the Grants.gov website. Comprehensive information about using Grants.gov is available on the Grants.gov Applicant Resources webpage: <https://www.grants.gov/web/grants/applicants.html>. In addition, the NSF Grants.gov Application Guide (see link in Section V.A) provides instructions regarding the technical preparation of proposals via Grants.gov. For Grants.gov user support, contact the Grants.gov Contact Center at 1-800-518-4726 or by email: support@grants.gov. The Grants.gov Contact Center answers general technical questions related to the use of Grants.gov. Specific questions related to this program solicitation should be referred to the NSF program staff contact(s) listed in Section VIII of this solicitation.

Submitting the Proposal: Once all documents have been completed, the Authorized Organizational Representative (AOR) must submit the application to Grants.gov and verify the desired funding opportunity and agency to which the application is submitted. The AOR must then sign and submit the application to Grants.gov. The completed application will be transferred to the NSF FastLane system for further processing.

Proposers that submitted via FastLane or Research.gov may use Research.gov to verify the status of their submission to NSF. For proposers that submitted via Grants.gov, until an application has been received and validated by NSF, the Authorized Organizational Representative may check the status of an application on Grants.gov. After proposers have received an e-mail notification from NSF, Research.gov should be used to check the status of an application.

VI. NSF PROPOSAL PROCESSING AND REVIEW PROCEDURES

Proposals received by NSF are assigned to the appropriate NSF program for acknowledgement and, if they meet NSF requirements, for review. All proposals are carefully reviewed by a scientist, engineer, or educator serving as an NSF Program Officer, and usually by three to ten other persons outside NSF either as *ad hoc* reviewers, panelists, or both, who are experts in the particular fields represented by the proposal. These reviewers are selected by Program Officers charged with oversight of the review process. Proposers are invited to suggest names of persons they believe are especially well qualified to review the proposal and/or persons they would prefer not review the proposal. These suggestions may serve as one source in the reviewer selection process at the Program Officer's discretion. Submission of such names, however, is optional. Care is taken to ensure that reviewers have no conflicts of interest with the proposal. In addition, Program Officers may obtain comments from site visits before recommending final action on proposals. Senior NSF staff further review recommendations for awards. A flowchart that depicts the entire NSF proposal and award process (and associated timeline) is included in PAPPG Exhibit III-1.

A comprehensive description of the Foundation's merit review process is available on the NSF website at: https://www.nsf.gov/bfa/dias/policy/merit_review/.

Proposers should also be aware of core strategies that are essential to the fulfillment of NSF's mission, as articulated in *Building the Future: Investing in Discovery and Innovation - NSF Strategic Plan for Fiscal Years (FY) 2018 – 2022*. These strategies are integrated in the program planning and implementation process, of which proposal review is one part. NSF's mission is particularly well-implemented through the integration of research and education and broadening participation in NSF programs, projects, and activities.

One of the strategic objectives in support of NSF's mission is to foster integration of research and education through the programs, projects, and activities it supports at academic and research institutions. These institutions must recruit, train, and prepare a diverse STEM workforce to advance the frontiers of science and participate in the U.S. technology-based economy. NSF's contribution to the national innovation ecosystem is to provide cutting-edge research under the guidance of the Nation's most creative scientists and engineers. NSF also supports development of a strong science, technology, engineering, and mathematics (STEM) workforce by investing in building the knowledge that informs improvements in STEM teaching and learning.

NSF's mission calls for the broadening of opportunities and expanding participation of groups, institutions, and geographic regions that are underrepresented in STEM disciplines, which is essential to the health and vitality of science and engineering. NSF is committed to this principle of diversity and deems it central to the programs, projects, and activities it considers and supports.

A. Merit Review Principles and Criteria

The National Science Foundation strives to invest in a robust and diverse portfolio of projects that creates new knowledge and enables breakthroughs in understanding across all areas of science and engineering research and education. To identify which projects to support, NSF relies on a merit review process that incorporates consideration of both the technical aspects of a proposed project and its potential to contribute more broadly to advancing NSF's mission "to promote the progress of science; to advance the national health, prosperity, and welfare; to secure the national defense; and for other purposes." NSF makes every effort to conduct a fair, competitive, transparent merit review process for the selection of projects.

1. Merit Review Principles

These principles are to be given due diligence by PIs and organizations when preparing proposals and managing projects, by reviewers when reading and evaluating proposals, and by NSF program staff when determining whether or not to recommend proposals for funding and while overseeing awards. Given that NSF is the primary federal agency charged with nurturing and supporting excellence in basic research and education, the following three principles apply:

- All NSF projects should be of the highest quality and have the potential to advance, if not transform, the frontiers of knowledge.
- NSF projects, in the aggregate, should contribute more broadly to achieving societal goals. These "Broader Impacts" may be accomplished through the research itself, through activities that are directly related to specific research projects, or through activities that are supported by, but are complementary to, the project. The project activities may be based on previously established and/or innovative methods and approaches, but in either case must be well justified.
- Meaningful assessment and evaluation of NSF funded projects should be based on appropriate metrics, keeping in mind the likely correlation between the effect of broader impacts and the resources provided to implement projects. If the size of the activity is limited, evaluation of that activity in isolation is not likely to be meaningful. Thus, assessing the effectiveness of these activities may best be done at a higher, more aggregated, level than the individual project.

With respect to the third principle, even if assessment of Broader Impacts outcomes for particular projects is done at an aggregated level, PIs are expected to be accountable for carrying out the activities described in the funded project. Thus, individual projects should include clearly stated goals, specific descriptions of the activities that the PI intends to do, and a plan in place to document the outputs of those activities.

These three merit review principles provide the basis for the merit review criteria, as well as a context within which the users of the criteria can better understand their intent.

2. Merit Review Criteria

All NSF proposals are evaluated through use of the two National Science Board approved merit review criteria. In some instances, however, NSF will employ additional criteria as required to highlight the specific objectives of certain programs and activities.

The two merit review criteria are listed below. **Both** criteria are to be given **full consideration** during the review and decision-making processes; each criterion is necessary but neither, by itself, is sufficient. Therefore, proposers must fully address both criteria. (PAPPG Chapter II.C.2.d(i). contains additional information for use by proposers in development of the Project Description section of the proposal). Reviewers are strongly encouraged to review the criteria, including PAPPG Chapter II.C.2.d(i), prior to the review of a proposal.

When evaluating NSF proposals, reviewers will be asked to consider what the proposers want to do, why they want to do it, how they plan to do it, how they will know if they succeed, and what benefits could accrue if the project is successful. These issues apply both to the technical aspects of the proposal and the way in which the project may make broader contributions. To that end, reviewers will be asked to evaluate all proposals against two criteria:

- **Intellectual Merit:** The Intellectual Merit criterion encompasses the potential to advance knowledge; and
- **Broader Impacts:** The Broader Impacts criterion encompasses the potential to benefit society and contribute to the achievement of specific, desired societal outcomes.

The following elements should be considered in the review for both criteria:

1. What is the potential for the proposed activity to
 - a. Advance knowledge and understanding within its own field or across different fields (Intellectual Merit); and
 - b. Benefit society or advance desired societal outcomes (Broader Impacts)?
2. To what extent do the proposed activities suggest and explore creative, original, or potentially transformative concepts?
3. Is the plan for carrying out the proposed activities well-reasoned, well-organized, and based on a sound rationale? Does the plan incorporate a mechanism to assess success?
4. How well qualified is the individual, team, or organization to conduct the proposed activities?
5. Are there adequate resources available to the PI (either at the home organization or through collaborations) to carry out the proposed activities?

Broader impacts may be accomplished through the research itself, through the activities that are directly related to specific research projects, or through activities that are supported by, but are complementary to, the project. NSF values the advancement of scientific knowledge and activities that contribute to achievement of societally relevant outcomes. Such outcomes include, but are not limited to: full participation of women, persons with disabilities, and underrepresented minorities in science, technology, engineering, and mathematics (STEM); improved STEM education and educator development at any level; increased public scientific literacy and public engagement with science and technology; improved well-being of individuals in society; development of a diverse, globally competitive STEM workforce; increased partnerships between academia, industry, and others; improved national security; increased economic competitiveness of the United States; and enhanced infrastructure for research and education.

Proposers are reminded that reviewers will also be asked to review the Data Management Plan and the Postdoctoral Researcher Mentoring Plan, as appropriate.

Additional Solicitation Specific Review Criteria

- **Participant Recruitment:** Is the recruitment and selection process described with sufficient detail? Is the recruitment plan likely to attract a diverse population of students that would benefit from the proposed activities?
- **PI Team:** Does the project team have sufficient experience in supporting students in the types of activities being proposed?
- **Institutional Commitment:** Do the letter(s) of commitment from collaborating organizations provide evidence of support for the project sufficient to achieve the goals and objectives?
- **Connection to Research on Geoscience Education:** How well informed are the vision and execution plan by the literature and prior attempts, if applicable, to implement change. Is the expectation of success well-justified?
- **Connection to Careers:** Is there a sufficient connection in the proposed project to viable career paths in the geosciences?
- **Student Mentoring Plan:** Is there a mentoring plan in place for student participants? Does the plan include sufficient training for faculty to successfully undertake their roles as mentors and supervisors of the student participants?
- **Documenting Impact:** Will the evaluation and monitoring plan provide sufficient documentation that project goals and outcomes have been realized?
- **Potential for Sustainability:** What is the potential for sustaining project activities and/or institutional collaborations after funding ends?

B. Review and Selection Process

Proposals submitted in response to this program solicitation will be reviewed by Ad hoc Review and/or Panel Review, or Internal NSF Review.

Ad hoc Review and/or Panel Review, or Internal NSF Review.

Reviewers will be asked to evaluate proposals using two National Science Board approved merit review criteria and, if applicable, additional program specific criteria. A summary rating and accompanying narrative will generally be completed and submitted by each reviewer and/or panel. The Program Officer assigned to manage the proposal's review will consider the advice of reviewers and will formulate a recommendation.

After scientific, technical and programmatic review and consideration of appropriate factors, the NSF Program Officer recommends to the cognizant Division Director whether the proposal should be declined or recommended for award. NSF strives to be able to tell applicants whether their proposals have been declined or recommended for funding within six months. Large or particularly complex proposals or proposals from new awardees may require additional review and processing time. The time interval begins on the deadline or target date, or receipt date, whichever is later. The interval ends when the Division Director acts upon the Program Officer's recommendation.

After programmatic approval has been obtained, the proposals recommended for funding will be forwarded to the Division of Grants and Agreements for review of business, financial, and policy implications. After an administrative review has occurred, Grants and Agreements Officers perform the processing and issuance of a grant or other agreement. Proposers are cautioned that only a Grants and Agreements Officer may make commitments, obligations or awards on

behalf of NSF or authorize the expenditure of funds. No commitment on the part of NSF should be inferred from technical or budgetary discussions with a NSF Program Officer. A Principal Investigator or organization that makes financial or personnel commitments in the absence of a grant or cooperative agreement signed by the NSF Grants and Agreements Officer does so at their own risk.

Once an award or declination decision has been made, Principal Investigators are provided feedback about their proposals. In all cases, reviews are treated as confidential documents. Verbatim copies of reviews, excluding the names of the reviewers or any reviewer-identifying information, are sent to the Principal Investigator/Project Director by the Program Officer. In addition, the proposer will receive an explanation of the decision to award or decline funding.

VII. AWARD ADMINISTRATION INFORMATION

A. Notification of the Award

Notification of the award is made to *the submitting organization* by a Grants Officer in the Division of Grants and Agreements. Organizations whose proposals are declined will be advised as promptly as possible by the cognizant NSF Program administering the program. Verbatim copies of reviews, not including the identity of the reviewer, will be provided automatically to the Principal Investigator. (See Section VI.B. for additional information on the review process.)

B. Award Conditions

An NSF award consists of: (1) the award notice, which includes any special provisions applicable to the award and any numbered amendments thereto; (2) the budget, which indicates the amounts, by categories of expense, on which NSF has based its support (or otherwise communicates any specific approvals or disapprovals of proposed expenditures); (3) the proposal referenced in the award notice; (4) the applicable award conditions, such as Grant General Conditions (GC-1)*; or Research Terms and Conditions* and (5) any announcement or other NSF issuance that may be incorporated by reference in the award notice. Cooperative agreements also are administered in accordance with NSF Cooperative Agreement Financial and Administrative Terms and Conditions (CA-FATC) and the applicable Programmatic Terms and Conditions. NSF awards are electronically signed by an NSF Grants and Agreements Officer and transmitted electronically to the organization via e-mail.

*These documents may be accessed electronically on NSF's Website at https://www.nsf.gov/awards/managing/award_conditions.jsp?org=NSF. Paper copies may be obtained from the NSF Publications Clearinghouse, telephone (703) 292-8134 or by e-mail from nsfpubs@nsf.gov.

More comprehensive information on NSF Award Conditions and other important information on the administration of NSF awards is contained in the NSF *Proposal & Award Policies & Procedures Guide* (PAPPG) Chapter VII, available electronically on the NSF Website at https://www.nsf.gov/publications/pub_summ.jsp?ods_key=pappg.

Special Award Conditions:

All IUUSE: GEOPATHS projects should expect to participate in data collection and evaluation at the level of the national program as well as at least one Principal Investigator meeting. As such, proposals should include planning for this work in management structures and in budgets.

C. Reporting Requirements

For all multi-year grants (including both standard and continuing grants), the Principal Investigator must submit an annual project report to the cognizant Program Officer no later than 90 days prior to the end of the current budget period. (Some programs or awards require submission of more frequent project reports). No later than 120 days following expiration of a grant, the PI also is required to submit a final project report, and a project outcomes report for the general public.

Failure to provide the required annual or final project reports, or the project outcomes report, will delay NSF review and processing of any future funding increments as well as any pending proposals for all identified PIs and co-PIs on a given award. PIs should examine the formats of the required reports in advance to assure availability of required data.

PIs are required to use NSF's electronic project-reporting system, available through Research.gov, for preparation and submission of annual and final project reports. Such reports provide information on accomplishments, project participants (individual and organizational), publications, and other specific products and impacts of the project. Submission of the report via Research.gov constitutes certification by the PI that the contents of the report are accurate and complete. The project outcomes report also must be prepared and submitted using Research.gov. This report serves as a brief summary, prepared specifically for the public, of the nature and outcomes of the project. This report will be posted on the NSF website exactly as it is submitted by the PI.

More comprehensive information on NSF Reporting Requirements and other important information on the administration of NSF awards is contained in the NSF *Proposal & Award Policies & Procedures Guide* (PAPPG) Chapter VII, available electronically on the NSF Website at https://www.nsf.gov/publications/pub_summ.jsp?ods_key=pappg.

VIII. AGENCY CONTACTS

Please note that the program contact information is current at the time of publishing. See program website for any updates to the points of contact.

General inquiries regarding this program should be made to:

- M. Brandon Jones, telephone: (703) 292-4713, email: mbjones@nsf.gov
- Elizabeth L. Rom, GEO/OCE & GEO/PLR, telephone: (703) 292-7709, email: elrom@nsf.gov
- Amanda (Manda) S. Adams, GEO/AGS, telephone: (703) 292-8521, email: amadams@nsf.gov
- Aisha R. Morris, telephone: (703) 292-7081, email: armorris@nsf.gov

For questions related to the use of FastLane or Research.gov, contact:

- FastLane and Research.gov Help Desk: 1-800-673-6188
FastLane Help Desk e-mail: fastlane@nsf.gov.
Research.gov Help Desk e-mail: rgov@nsf.gov

For questions relating to Grants.gov contact:

- Grants.gov Contact Center: If the Authorized Organizational Representatives (AOR) has not received a confirmation message from Grants.gov within 48 hours of submission of application, please contact via telephone: 1-800-518-4726; e-mail: support@grants.gov.

PLEASE NOTE: The [IUSE:GEOPATHS](#) solicitation is undergoing revisions and will be released in early Fall. Exact due-dates for the new solicitation are yet to be determined. Please monitor this website periodically for status updates or sign up for the NSF listserv for solicitation updates.

IX. OTHER INFORMATION

The NSF website provides the most comprehensive source of information on NSF Directorates (including contact information), programs and funding opportunities. Use of this website by potential proposers is strongly encouraged. In addition, "NSF Update" is an information-delivery system designed to keep potential proposers and other interested parties apprised of new NSF funding opportunities and publications, important changes in proposal and award policies and procedures, and upcoming NSF [Grants Conferences](#). Subscribers are informed through e-mail or the user's Web browser each time new publications are issued that match their identified interests. "NSF Update" also is available on [NSF's website](#).

Grants.gov provides an additional electronic capability to search for Federal government-wide grant opportunities. NSF funding opportunities may be accessed via this mechanism. Further information on Grants.gov may be obtained at <https://www.grants.gov>.

ABOUT THE NATIONAL SCIENCE FOUNDATION

The National Science Foundation (NSF) is an independent Federal agency created by the National Science Foundation Act of 1950, as amended (42 USC 1861-75). The Act states the purpose of the NSF is "to promote the progress of science; [and] to advance the national health, prosperity, and welfare by supporting research and education in all fields of science and engineering."

NSF funds research and education in most fields of science and engineering. It does this through grants and cooperative agreements to more than 2,000 colleges, universities, K-12 school systems, businesses, informal science organizations and other research organizations throughout the US. The Foundation accounts for about one-fourth of Federal support to academic institutions for basic research.

NSF receives approximately 55,000 proposals each year for research, education and training projects, of which approximately 11,000 are funded. In addition, the Foundation receives several thousand applications for graduate and postdoctoral fellowships. The agency operates no laboratories itself but does support National Research Centers, user facilities, certain oceanographic vessels and Arctic and Antarctic research stations. The Foundation also supports cooperative research between universities and industry, US participation in international scientific and engineering efforts, and educational activities at every academic level.

Facilitation Awards for Scientists and Engineers with Disabilities (FASSED) provide funding for special assistance or equipment to enable persons with disabilities to work on NSF-supported projects. See the *NSF Proposal & Award Policies & Procedures Guide* Chapter II.E.6 for instructions regarding preparation of these types of proposals.

The National Science Foundation has Telephonic Device for the Deaf (TDD) and Federal Information Relay Service (FIRS) capabilities that enable individuals with hearing impairments to communicate with the Foundation about NSF programs, employment or general information. TDD may be accessed at (703) 292-5090 and (800) 281-8749, FIRS at (800) 877-8339.

The National Science Foundation Information Center may be reached at (703) 292-5111.

The National Science Foundation promotes and advances scientific progress in the United States by competitively awarding grants and cooperative agreements for research and education in the sciences, mathematics, and engineering.

To get the latest information about program deadlines, to download copies of NSF publications, and to access abstracts of awards, visit the NSF Website at <https://www.nsf.gov>

- **Location:** 2415 Eisenhower Avenue, Alexandria, VA 22314

- **For General Information** (NSF Information Center): (703) 292-5111
- **TDD (for the hearing-impaired):** (703) 292-5090
- **To Order Publications or Forms:**
 - Send an e-mail to: nsfpubs@nsf.gov
 - or telephone: (703) 292-7827
- **To Locate NSF Employees:** (703) 292-5111

PRIVACY ACT AND PUBLIC BURDEN STATEMENTS

The information requested on proposal forms and project reports is solicited under the authority of the National Science Foundation Act of 1950, as amended. The information on proposal forms will be used in connection with the selection of qualified proposals; and project reports submitted by awardees will be used for program evaluation and reporting within the Executive Branch and to Congress. The information requested may be disclosed to qualified reviewers and staff assistants as part of the proposal review process; to proposer institutions/grantees to provide or obtain data regarding the proposal review process, award decisions, or the administration of awards; to government contractors, experts, volunteers and researchers and educators as necessary to complete assigned work; to other government agencies or other entities needing information regarding applicants or nominees as part of a joint application review process, or in order to coordinate programs or policy; and to another Federal agency, court, or party in a court or Federal administrative proceeding if the government is a party. Information about Principal Investigators may be added to the Reviewer file and used to select potential candidates to serve as peer reviewers or advisory committee members. See [System of Record Notices](#), NSF-50, "Principal Investigator/Proposal File and Associated Records," and NSF-51, "Reviewer/Proposal File and Associated Records." Submission of the information is voluntary. Failure to provide full and complete information, however, may reduce the possibility of receiving an award.

An agency may not conduct or sponsor, and a person is not required to respond to, an information collection unless it displays a valid Office of Management and Budget (OMB) control number. The OMB control number for this collection is 3145-0058. Public reporting burden for this collection of information is estimated to average 120 hours per response, including the time for reviewing instructions. Send comments regarding the burden estimate and any other aspect of this collection of information, including suggestions for reducing this burden, to:

Suzanne H. Plimpton
 Reports Clearance Officer
 Office of the General Counsel
 National Science Foundation
 Alexandria, VA 22314

[Policies and Important Links](#)

[Privacy](#)

[FOIA](#)

[Help](#)

[Contact NSF](#)

[Contact Web Master](#)

[SiteMap](#)



National Science Foundation, 2415 Eisenhower Avenue, Alexandria, Virginia 22314, USA
 Tel: (703) 292-5111, FIRS: (800) 877-8339 | TDD: (703) 292-5090 or (800) 281-8749

[Text Only](#)