SEISMOLOGICAL FACILITY FOR THE ADVANCEMENT OF GEOSCIENCE (SAGE)
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Seismological Facility for the Advancement of Geoscience Funding
(Dollars in Millions)

FY 2022 Actual	FY 2023 Estimate Base	FY 2024 Request	Change over FY 2023 Estimate Base Amount	Percent
$21.87	$23.37	$24.40	$1.03	4.4%

Brief Description

The Seismological Facility for the Advancement of Geoscience is a distributed, multi-user facility that enables a diverse principal investigator community to make advances in understanding Earth processes that would otherwise not be possible. SAGE provides the research community with access to seismic instrumentation, field training and support, and data services. The facility operates a global network of seismic stations; provides field and technical resources; supports data archiving, quality control, and distribution; and provides education and outreach activities that serve a wide range of audiences. SAGE deploys geophysical instruments globally onland, in polar regions, and under the oceans.

Meeting Scientific Community Needs

The Earth's interior remains a major scientific frontier holding the key to understanding the origin of the planet. Recent developments in seismic sensor design and the acquisition, transmission, and storage of data have resulted in dramatic improvements in the resolving power of seismic imaging of the Earth’s interior. To serve the research needs of the broad Earth science community, SAGE is organized under three primary service areas: Instrumentation Services, Data Services, and Education and Public Outreach.

Users include researchers who utilize SAGE instruments and/or data; educators who draw on SAGE teaching materials and training; other Federal agencies and international groups that employ SAGE resources and/or data for multiple operational purposes; and interested members of the public and private sector.

SAGE provides open access data and educational products at no cost to users. Scientists utilizing equipment, training, and other resources provided by SAGE typically are funded by awards from NSF, the U.S. Geological Survey (USGS), and other agencies. NSF-sponsored users are usually supported by the Division of Earth Sciences (EAR), the Division of Ocean Sciences(OCE), and OPP.

Demand remains high for data, equipment, and other resources provided by SAGE. In FY 2022:
- The total amount of data downloaded from the SAGE Data Management Center was the highest ever, with an increase of three percent over FY 2021;
- At least 91 field experiments used equipment and support provided by SAGE worldwide; and
- More than 300,000 classroom activities were downloaded by K-16 educational projects.

Status of the Facility

SAGE is currently in year five of a seven-year award, and the capabilities provided by the facility have evolved based on input from a series of community engagement activities, including an NSF-sponsored workshop entitled "Future Seismic and Geodetic Facility Needs in the Geosciences" held in 2015.[1] EAR continues to evaluate NSF's geophysical facilities to best enable emerging research directions. In 2018, EAR commissioned a National Academies of Sciences, Engineering, and Medicine decadal survey that identified top research priorities for the Earth sciences for the next decade. Released in July 2020, *A Vision for NSF Earth Sciences 2020-2030: Earth in Time*[2] reaffirmed the importance of NSF's seismic and geodetic facilities in advancing Earth science research over the next decade.

As part of the decadal survey process, a workshop entitled *Management Models for Future Seismological and Geodetic Facilities and Capabilities* was held to review the strengths and weaknesses of different management models for NSF geophysical facilities.[3] Following the release of the workshop report, EAR announced that, at the time of the next competition for their management and operations, the current SAGE and Geodetic Facility for the Advancement of GEoscience (GAGE) facilities would be consolidated into a single facility with a single operator.[4]

In FY 2020, GEO commissioned a portfolio review from a subcommittee of its Advisory Committee to inform planning for the future, consolidated geophysical facility. The portfolio review is also an important input to an ongoing effort to plan seismic research and related infrastructure in the U.S. over the next decade, so that NSF's geophysical facility will address the science priorities highlighted in the decadal survey. Additionally, the portfolio review report, which was completed in FY 2021, emphasized the importance of developing partnerships in support of elements of SAGE and GAGE that are mission critical for other Federal agencies. EAR is working to define the best path forward for a future facility and undertaking efforts to expand existing federal partnerships.

Governance Structure and Partnerships

NSF Governance Structure

NSF oversight is provided by EAR, working cooperatively with OPP, the Office of the General Counsel, the Office of Legislative and Public Affairs, and the Office of Budget, Finance, and Award Management (BFA). Within BFA, the Large Facilities Office advises program staff and assists with agency oversight. The GEO facilities team and the Chief Officer for Research Facilities also provide high-level guidance, support, and oversight.

External Governance Structure

The SAGE facility awardee is a 501(c)(3) nonprofit corporation governed by a Board of Directors elected by institutional representatives. As of January 1, 2023, the Incorporated Research Institutions for Seismology (IRIS), Inc., which managed SAGE since the start of the current award in FY 2018, and UNAVCO (the managing entity for GAGE since the start of the current GAGE award in FY 2018) merged

[1] www.iris.edu/hq/files/workshops/2015/05/fusg/reports/futures_report_high.pdf

[2] www.nap.edu/catalog/25761/a-vision-for-nsf-earth-sciences-2020-2030-earth-in

[3] www.nap.edu/catalog/25536/management-models-for-future-seismological-and-geodetic-facilities-and-capabilities

[4] www.nsf.gov/pubs/2020/nsf20037/nsf20037.jsp

to form the EarthScope Consortium, Inc., with over 170 institutional members. This consortium now manages both GAGE and SAGE as discrete major facilities. Board members vet program decisions associated with SAGE management and operation through consultation with EarthScope Consortium staff and SAGE advisory committees.

Partnerships and Other Funding Sources

The GAGE facility is primarily supported by EAR. SAGE is heavily involved in partnership activities, many of which are international in nature. Installation and operations of the Global Seismographic Network (GSN) have resulted in contacts between scientists and government and non-government organizations around the world. Many international GSN stations are designated as the official stations for nuclear test ban treaty monitoring in their host countries. The USGS supports operation of two-thirds of the GSN.

Funding

Total Obligations for SAGE

(Dollars in Millions)

		FY 2023						
	FY 2022	Estimate	FY 2024	**ESTIMATES[1]**				
	Actual	Base	Request	FY 2025	FY 2026	FY 2027	FY 2028	FY 2029
Operations & Maintenance	$21.87	$23.37	$24.40	$24.75	$24.75	$24.75	$24.75	$24.75

[1] Outyear estimates are for planning purposes only. The current cooperative agreement ends in September 2025. In 2020, NSF announced preparation for a competition for a future single, unified geophysical facility as the successor to SAGE and GAGE.

NSF is currently implementing recommendations from the community and prior reviews that include innovating SAGE's portable sensor pool to provide additional nodal instruments for studies of processes in Earth's near surface, moving data services for the facility to the cloud and recapitalizing aging instrumentation. A pilot cloud service program was initiated in 2020 in partnership with GAGE and the program plans to expand this capability over the remainder of the existing award period. The program is also implementing different strategies to address aging instrumentation, and plans to continue to phase in recapitalization over the current award period.

Reviews and Reports

NSF externally reviews components of the SAGE facility on an annual basis. In 2022, NSF conducted a review of the SAGE Education and Community Engagement activity, which was described by the review panel as "unparalleled and impactful" and having "an outsize[d] influence on Earth-sciences culture" in partnership with GAGE. NSF conducted a full management review of SAGE in September 2021, and the panel commended IRIS for its strong overall performance in operating and maintaining SAGE. NSF will conduct a follow-up review of the full facility in 2023.

Renewal/Recompetition/Disposition

In 2020, NSF announced preparation for a competition for a future single, unified geophysical facility as the successor to GAGE and SAGE. NSF plans to evolve components of GAGE and SAGE through the competition for the future facility to enable advances in the scientific priorities established by the *Earth in Time* decadal survey. NSF is considering the recommendations in the FY 2021 portfolio review, as

well as the interagency context, to formulate a strategy for continued support of this important community research resource. Disposition is not being considered at this time.

While the SAGE award was initially planned to end in 2023, NSF announced in June 2021 that it would extend the current awards for operations of both SAGE and GAGE to ensure continuity of services until 2025. This extension will allow NSF to work with agency partners to thoughtfully respond to the recommendations in the portfolio review.