

FACILITATE COLLABORATE EDUCATE

2015 Annual Report



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IRIS Vision

IRIS is a world leader in advancing discovery, research, and education in seismology to understand our planet and to benefit society.

IRIS Mission

- Facilitate investigations of seismic sources and Earth properties using seismic and other geophysical methods.
- Promote exchange of seismic and other geophysical data and knowledge through the use of standards for network operations and data formats, and through pursuing policies of free and unrestricted data access.
- Foster cooperation among IRIS members, affiliates, and other organizations in order to advance seismological research and education, and improve Earth science literacy in the general public.



A MESSAGE FROM THE PRESIDENT



I joined IRIS as President in April 2014, just a few weeks before the IRIS Consortium celebrated its thirtieth anniversary and three decades of support for the seismological research community. The main goals laid out in IRIS' original 1984 "Rainbow Proposal" have been largely achieved. A permanent Global Seismographic Network with over 150 stations has been established (at least on land), a large pool of portable broadband and short-period seismographs is now available for investigators to use for shorter-term experiments anywhere in the world, and the IRIS Data Management Center maintains the largest collection of freely available waveform seismic data in the world.

However, as you glance through this Annual Report, you will see that IRIS is doing much more, including things that were hardly imagined 30 years ago. Over the last decade, EarthScope's USArray, operated by IRIS, carried out a rolling deployment of 400 seismic stations that occupied ~1,700 sites across the United States and collected data from hundreds of magnetotelluric stations. The Transportable Array stations are now being deployed to Alaska in one of the most logistically

and technically challenging seismic experiments ever attempted. IRIS now routinely collects seismic data in Antarctica and Greenland, and through the National Science Foundation-funded Ocean Bottom Seismograph Instrument Pool, on the seafloor. A new generation of compact, portable sensors will soon allow us to deploy a thousand or more instruments for a single experiment. And IRIS' education and outreach programs are actively promoting the development of a diverse geoscience workforce and improving Earth science literacy in the general public.

I'm excited by these new opportunities to support the seismological research community, and I hope this annual report will help you see the ways in which IRIS is continuing to advance discovery, research, and education to understand our planet and benefit society.

A handwritten signature in black ink, appearing to read "Bob Detrick". The signature is stylized and cursive.

Bob Detrick
President

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Science is a human endeavor, driven by curiosity, passion, creativity, and innovation.

Since its founding in 1984, IRIS has supported individuals pursuing scientific advances on some of the most challenging geoscience problems: illuminating the internal dynamics of our planet; the causes and consequences of earthquakes; and interactions between the solid Earth and surface processes, climate, and hydrology. Organized exclusively for educational and scientific purposes, IRIS programs have contributed to new discoveries within our planet; natural hazard mitigation; national security; environmental monitoring; advances in computation, networking, and communications; building a scientifically and technologically proficient workforce; and inspiring the next generation of Earth scientists.

While the facilities we operate and maintain, and the services we provide, are essential to making scientific advances, our most valuable asset is people—the community of scientists, educators, and skilled professional staff who, through their daily efforts, facilitate, collaborate, and educate, making discoveries that inform and inspire.

The IRIS community has grown since its inception from 26 founding institutions to 122 member institutions, 126 foreign affiliates, and 25 educational and other

affiliates. IRIS was and remains at the vanguard of efforts to promote open data access and exchange, efforts that have facilitated and significantly advanced Earth science research and education nationally and internationally. Through shared facilities and services and an open data archive, it is possible for any academic institution in the United States to develop and maintain a program in seismology.

Building upon our initial charge to operate core facilities for seismology, IRIS has evolved and grown to undertake a broader array of activities in order to advance our goals of expanding into the ocean and polar regions, supporting large-scale community experiments, and facilitating advances in both technical and human capacities in developing countries.

As you look through the pages of this annual report you will see the many ways that the IRIS Consortium, scientists, educators, and technical staff advance science and innovation through their curiosity, passion, and creativity.

Anne Meltzer
Chair, Board of Directors



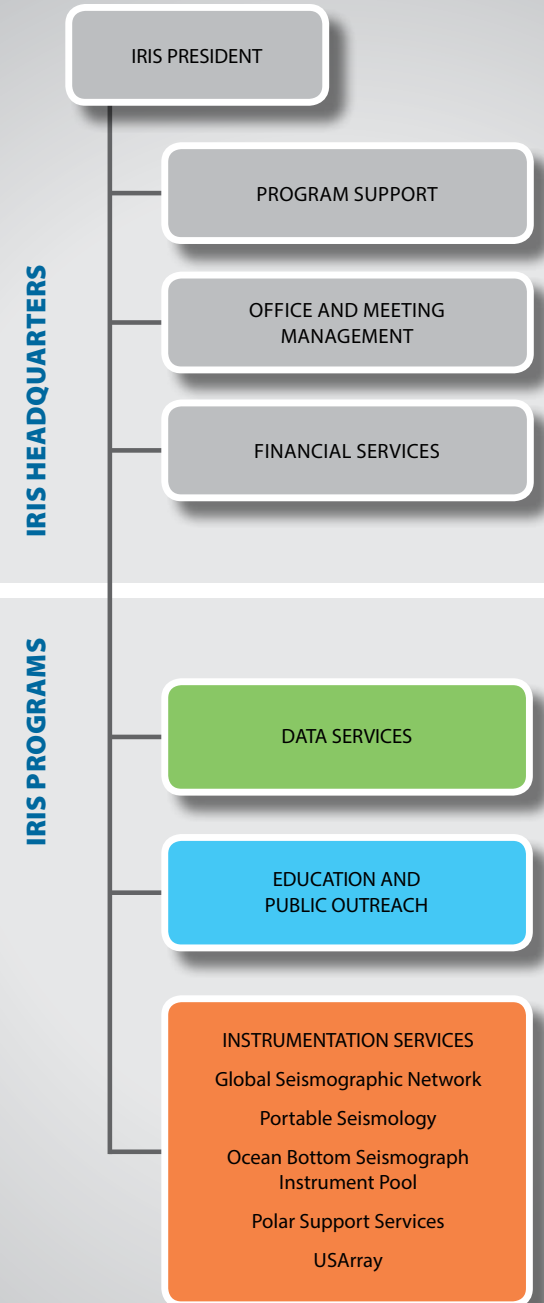
IRIS ORGANIZATION

For 30 years, IRIS—a not-for-profit consortium of 122 US universities and research institutions across the country—has been supported by the National Science Foundation and governed by its Consortium members to manage key infrastructure resources that support academic research in seismology. A nine-member Board of Directors acts on behalf of the Member Institutions and serves as the major decision-making forum for IRIS in guiding the programmatic, management, and fiscal activities of the Corporation and Consortium. It sets goals and policies, reviews and approves program plans and budgets, receives advice from Board-appointed committees, and directs the activities of the President and staff.

IRIS facility management is based on linked operational structures for the main programmatic areas—Instrumentation Services (Global Seismographic Network, Portable Seismology, Ocean Bottom Seismograph Instrument Pool, Polar Support Services, and USArray), Data Services, and Education and Public Outreach. The central administrative and business

functions are carried out through a Headquarters Office in Washington, DC. The programs are managed through offices or subawards linked to each of the programs. Overall management is under the direction of a full-time President, appointed by the IRIS Board of Directors, who works with a Senior Management Team that includes the directors of each of the primary program directorates.

IRIS has adopted a community-based governance structure for all of the NSF-sponsored programs it manages. Standing and advisory committees with members from the seismological community meet regularly, usually twice a year, and provide advice on facility operations, budget priorities, and future needs. Strong community guidance and oversight of IRIS-operated facilities through this governance structure is essential for ensuring that these facilities remain cutting edge and continue to serve the highest priority needs of the scientific community.



IRIS PROGRAMS

The 153-station **Global Seismographic Network (GSN)** is a permanent telemetered network of seismological and geophysical sensors. A key source of free and open data for seismological research and Earth science education, the GSN is also a principal global source of data for earthquake locations, earthquake hazard mitigation, earthquake emergency response, and tsunami warning. In a unique partnership, the GSN is operated and maintained by the US Geological Survey Albuquerque Seismological Laboratory and the University of California, San Diego, IRIS/IDA group funded by the National Science Foundation and managed by IRIS. Twenty-two affiliate stations and arrays around the globe contribute to the network, including the nine-station USGS Caribbean Network.

IRIS **Portable Seismology** provides end-to-end experiment support services, state-of-the-art instrumentation, and advanced field and database management tools for diverse scientific and educational communities worldwide. Over its history, the IRIS PASSCAL facility has supported deployment of over 1,000 experiments. The data collected further understanding of natural hazards, groundwater resources, and deep Earth structure. By integrating planning, logistical, instrumentation, and engineering services, and supporting the efforts with full-time professional staff, IRIS has enabled seismologists to mount large-scale experiments throughout the United States and around the globe.



The **USArray Transportable Array**, a part of EarthScope, is a set of 400 high-quality seismographs that are placed in temporary sites for two years of observations and then moved to the next set of grid points. The project began operations on the US West Coast in 2005, and after 10 years, it has crossed the entire United States to the Atlantic seaboard. It will finish there in 2015, while at the same time, the Alaska Transportable Array is being deployed. With a nearly uniform spacing of about 70 km, the instruments record global and local earthquakes, and even ground shaking from storms at sea. These data are used to model Earth structure as shallow as a few kilometers to as deep as the core-mantle boundary at nearly 3,000 km depth, enabling a better understanding of the structure and evolution of the North American continent.

Since 2006, the **Magnetotelluric Array (MT)** component of EarthScope's USArray has deployed instruments that measure Earth's naturally occurring electric and magnetic fields. Its backbone array consists of seven stations across the country operated as a reference network. In addition, each summer up to 20 portable MT systems are deployed campaign style, occupying large footprints in areas of special interest in the Pacific Northwest, the Mid-Continent Rift, and most recently in the southeastern United States. Each site is occupied for approximately three weeks with a nominal 70 km grid spacing for imaging of crustal and lithospheric conductivity structure.

The **Ocean Bottom Seismograph Instrument Pool** (OBSIP) supports research to increase understanding of natural hazards, active Earth processes, and deep Earth structure by making available seismometers that are deployed on the ocean floor. Some of the instruments remain for months to years, passively recording local and distant earthquakes. Others are used for short-term experiments that employ man-made sound sources. The program is composed of a management office and three Institutional Instrument Contributors that provide both instruments and technical support—Lamont-Doherty Earth Observatory, Scripps Institution of Oceanography, and Woods Hole Oceanographic Institution.

Polar Support Services provides engineering support for experiments in Antarctica and the Arctic, maintains and updates a specialized pool of cold-rated equipment, and supports field operations in Earth's high-latitude regions. This engineering support, along with incorporating advances in technology, has greatly improved data quality and return from these extremely remote and logistically expensive polar regions, optimizing experiment costs and greatly improving the scientific return for seismologists and glaciologists alike.

The core mission of **Data Services** is to collect, curate, and distribute data collected by IRIS programs. Data Services also manages seismic data from other components of EarthScope, backbone stations from networks that are members of the International Federation of Digital Seismograph Networks, regional networks supported by the US Geological Survey, and stations operated by partner organizations worldwide. Data Services creates a wide range of data products, such as visualizations of wave propagation for researchers and specialized products for public outreach, and plays a key role in facilitating quality control of time series data managed at the IRIS Data Management Center.

The **Education and Public Outreach** program combines the seismological expertise of Consortium members with that of IRIS staff to create products and activities that advance awareness and understanding of seismology and geophysics while inspiring careers in Earth science. These products and activities are designed for use in diverse settings: self-directed exploration over the Web, interactive museum exhibits, major public lectures, and in-depth exploration of Earth's interior in formal middle school through undergraduate classrooms. Each year, a select group of undergraduates spends the summer conducting research under the expert guidance of scientists at Consortium member institutions and affiliates. IRIS staff also widely distribute animations and videos of earthquake and related processes and data visualization tools.



FACILITATE COLLABORATE EDUCATE

In 1984, the US academic seismology research community formed IRIS to define and prioritize its facility needs to support their expanding research efforts and to seek support from the National Science Foundation to establish, develop, and operate these facilities. Since then, IRIS has nurtured and grown the facilities that are now central to the Earth science research and education communities in seismology and related fields. Consortium membership has increased from the 26 original US member institutions to 122 today. Recognizing the importance of educational and international outreach and cooperation, membership now includes 22 educational and 126 foreign affiliates.

Central to the seismology community's success in conducting experiments globally, forming a range of long-term scientific collaborations, and disseminating results to other scientists as well as educators has been IRIS's commitment to:

- **Facilitate** global, regional, and local collection of seismic data and make these data openly available to any interested investigator
- **Collaborate** with government agencies, academic institutions, other organizations, and individuals around the globe to enable collection of data to promote basic and applied geophysical research
- **Educate** students, engage the public, and inform teachers and faculty









FACILITATE

The IRIS Consortium provides a suite of community-governed, multi-user facilities for instrumentation and data management to support research and education in seismology and the Earth sciences. A high-performance network of more than 150 permanent stations provides data for global studies of earthquakes and deep Earth structure. A mobile array of more than 400 seismometers and atmospheric sensors completed a traverse of the conterminous United States, and these sensors are currently being deployed in Alaska. More

than 4,000 portable instruments (including magnetotelluric systems) are available for short- and long-term loan to university-based researchers for detailed studies as part of National Science Foundation-funded field programs. Future observing needs are addressed through systematic engineering efforts. Data from all of these observational systems, along with extensive collections of seismic data contributed by other organizations, are freely and openly available through the IRIS Data Management Center.

Earthquake Hazards

“Can you predict earthquakes?” is among the questions that seismologists often hear in public discussions of their science. As yet, no method can reliably predict earthquakes—but it is important to understand that seismology is paving the way for a variety of activities that better protect us from the effects of earthquakes. Much as understanding the biology of disease leads demonstrably to more and better treatments, understanding the physics of earthquake rupture and wave propagation helps us to design our cities, critical infrastructure, and society to be more resilient when earthquakes occur.



“The rapid availability of sensors and telemetry expertise at IRIS PASSCAL has allowed us to quickly deploy stations in response to earthquake sequences in the Dallas-Fort Worth, TX, region since 2008, where the seismicity rate has increased nearly tenfold.”

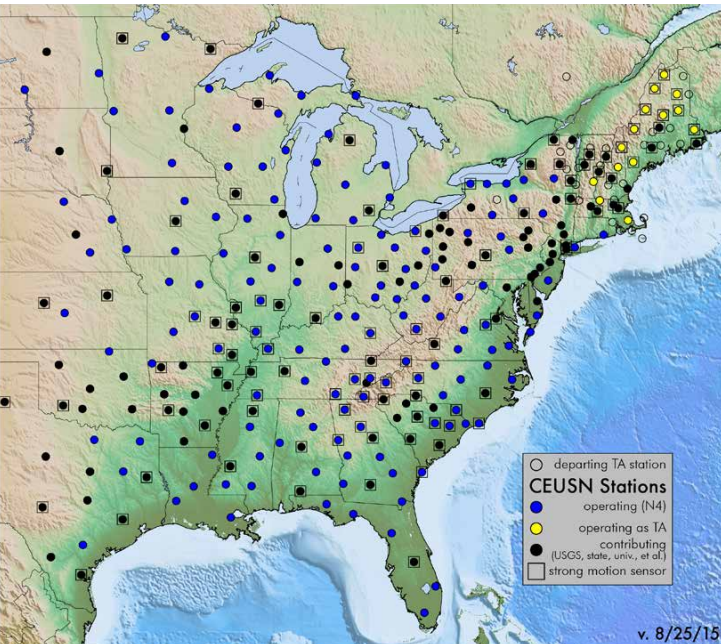
— Heather R. DeShon, Associate Professor,
Southern Methodist University

Plumbing the depths of Mt. St. Helens' magmatic system

The eruption of Mt. St. Helens on May 18, 1980, was the deadliest and most economically destructive volcanic eruption in the history of the United States. Imaging Magma Under St. Helens, or iMush, is a four-year project to illuminate the architecture of the volcano's magmatic system from the subducting slab to Earth's surface. The NSF-supported project is using multiple geophysical and geological techniques, including 70 passive long-term seismographs and 2,500 short-term seismographs for a controlled-source experiment—all borrowed from the IRIS PASSCAL and USArray Flexible Array instrument pools. These seismic sensors are being deployed on a scale rarely seen in research projects, and are enabled by use of cutting-edge “nodal” seismic recording systems.

Scientists hope to use the data collected by the iMUSH project to improve prediction of the timing and severity of volcanic eruptions.





Understanding earthquakes generated by human activities

The process of removing hydrocarbons from Earth's crust has become an essential activity for humankind. The stress generated from oil and natural gas production and the disposal of wastewater and brine following these operations can cause increased levels of earthquake activity, termed induced seismicity. IRIS operates and manages the Central and Eastern United States Network, which encompasses regions currently associated with potentially induced seismicity, such as Oklahoma, Texas, Arkansas, and Ohio. The network includes 159 broadband Transportable Array stations, more than 30 with strong motion sensors added, that are scheduled to operate through 2017.

The Central and Eastern United States Network, together with the existing coverage of permanently operating seismometers in the region, form a network of over 300 broadband stations.

The Amphibious Array: Seismometers crossing the shoreline

The Cascadia subduction zone off Washington, Oregon, and northern California is capable of generating a megathrust earthquake in the next 50 years. The National Science Foundation funded IRIS to deploy both ocean bottom and onshore seismometers across the subduction zone in a multiyear experiment that has made it possible to image the fault plane, record normally undetectable offshore earthquakes, and monitor faults and volcanoes in real time with high-rate GPS. IRIS coordinates with the Cascadia Initiative Expedition Team to deploy the land and oceanic instrumentation, and encourages dialogue with fisheries and other public interests.

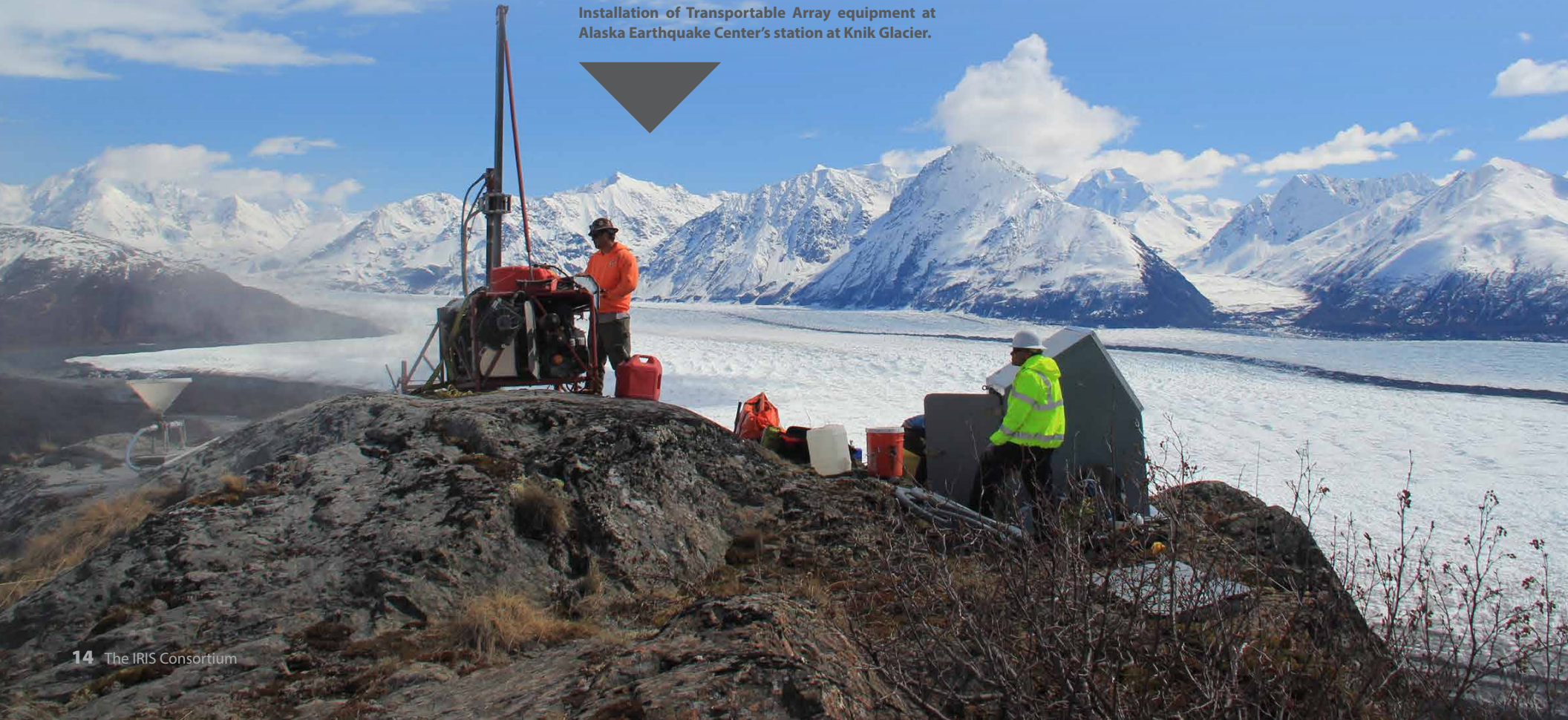
Numerous students and early career scientists have participated in fieldwork in the Cascadia project through the Apply to Sail and Community College at Sea programs.



Transportable Array–Alaska

Alaska has over 20,000 detectable earthquakes every year, about five times more than the rest of the continental United States combined. Alaska also contains over 130 volcanoes and volcanic fields that have been active within the past two million years. Large areas of this vast state have never been instrumented due to the challenges and hazards of remote fieldwork. Under USArray management, ~70 existing seismograph stations in Alaska will be upgraded and 190 new stations will be installed in a grid-like pattern with a spacing of ~85 km, covering all of interior Alaska and parts of the Yukon, Northwest Territories, and British Columbia. Real-time data from all stations are transmitted and distributed freely through the IRIS Data Management Center.

Installation of Transportable Array equipment at Alaska Earthquake Center's station at Knik Glacier.





Innovations make Alaska work possible

In order to operate in the challenging conditions in Alaska (remote locations, extremely cold temperatures, long, dark winters), construction and configuration of Transportable Array stations has required significant technological innovation. Most stations will use newly available posthole broadband seismometers. These sensors, combined with the new ability to place them in cased subsurface holes of two to five meters depth, are providing data that are substantially quieter than other types of installations. Transportable Array-Alaska stations will be powered by a cutting-edge, high-energy-density air-cell/lithium iron phosphate battery system that will provide power over the long winter. During the summer months, solar systems will provide the power to recharge these batteries.

Station deployment

Installation of the 260 Transportable Array stations in Alaska began in 2014 and will continue at an accelerating pace through the summer of 2017. It is hoped that the complete Alaska network will operate for at least two years.

Because a helicopter or fixed-wing aircraft is used to access most Transportable Array-Alaska stations, design requirements include reliable, low-weight seismometers.



Polar Support

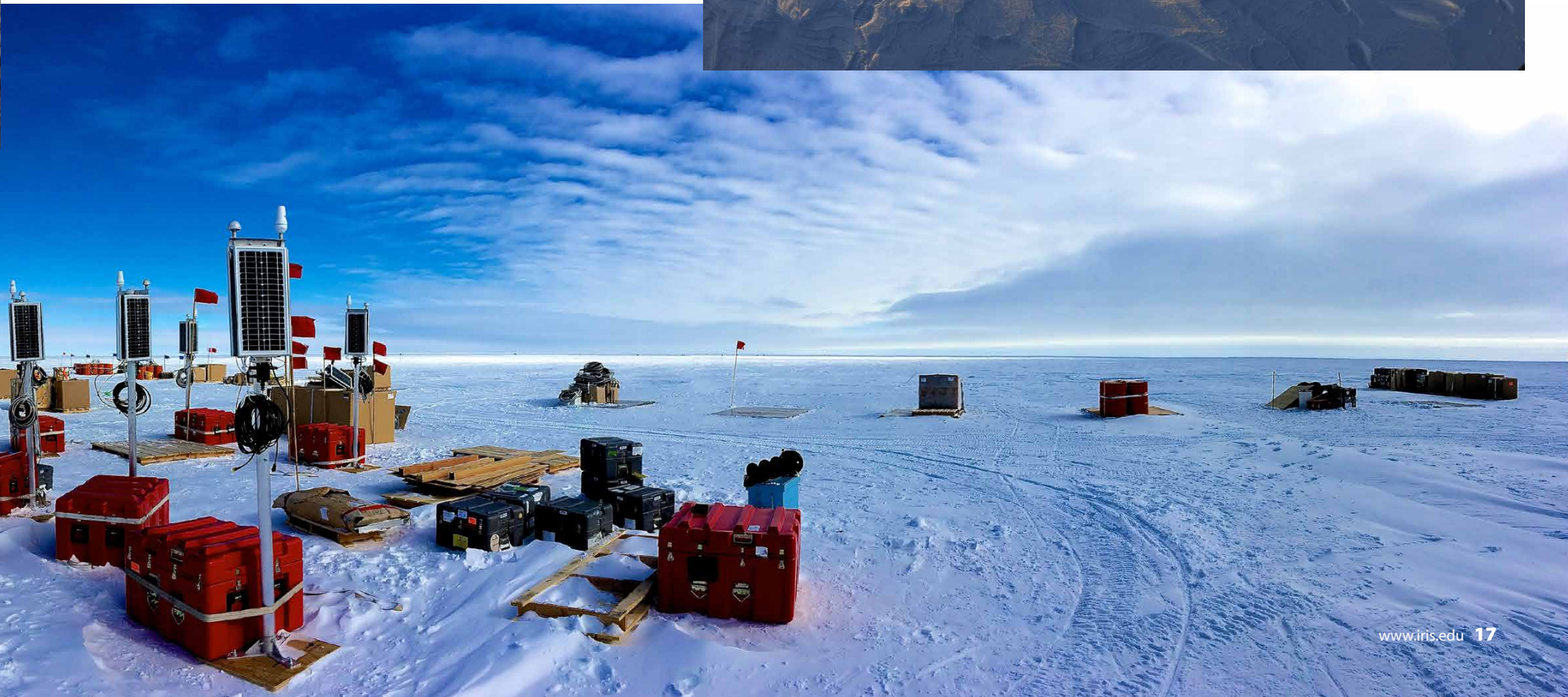
With the increased interest in the study of polar environments, IRIS has developed capabilities that have allowed seismologists and glaciologists to acquire year-round seismic data from study areas that were previously out of reach. Through NSF Major Research Instrumentation awards for instrument development and acquisition, and in collaboration with partner organizations (particularly UNAVCO), IRIS has successfully designed and developed smaller, lighter, and more robust observatory platforms that have facilitated high rates of data return from experiments in the most remote and extreme parts of the Arctic and Antarctic.

IRIS broadband seismographic systems being staged atop the Ross Ice Shelf for aircraft and snowmobile deployment in October 2014 as part of an NSF-supported project to study the ocean- and glaciological-driven dynamics of Earth's largest ice shelf (which is approximately the size of Texas), the glaciological and tectonic seismicity of Antarctica, and the underlying structure of the West Antarctic Rift System.



The IRIS-supported Greenland Ice Sheet Monitoring Network (GLISN) allows scientists to observe the seismic signatures resulting from the rapid draining of subglacial lakes, which could have implications for ice sheet stability and melt rates. The real-time data provided by GLISN's 33 seismic stations will allow scientists to stay on top of future changes in this changing land.

Recent deployments of broadband seismometers on or adjacent to ice sheets and icebergs on Greenland and Antarctica have recorded calving of ice off the end of glaciers and iceberg fracturing. The records are yielding new insights into these processes, which may be accelerating due to climate change.



COLLABORATE

Over its 30-year history of operations, IRIS has collaborated with numerous federal agencies, foreign governments, and academic researchers in the United States and around the world to promote best practices of open data availability, full retention of maximum bandwidth, continuous data recording, and direct community access to state-of-the-art seismological instrumentation and software. For example, since its inception, IRIS has collaborated closely with the International Federation of Digital Seismograph Networks in global site selection of high-quality permanent seismograph stations and in encouraging policies for free and open data exchange. IRIS shares knowledge gained and lessons learned from more than 30 years of operating seismological infrastructure by conducting training courses that encourage the creation and/or operation of high-quality, sustainable networks worldwide.

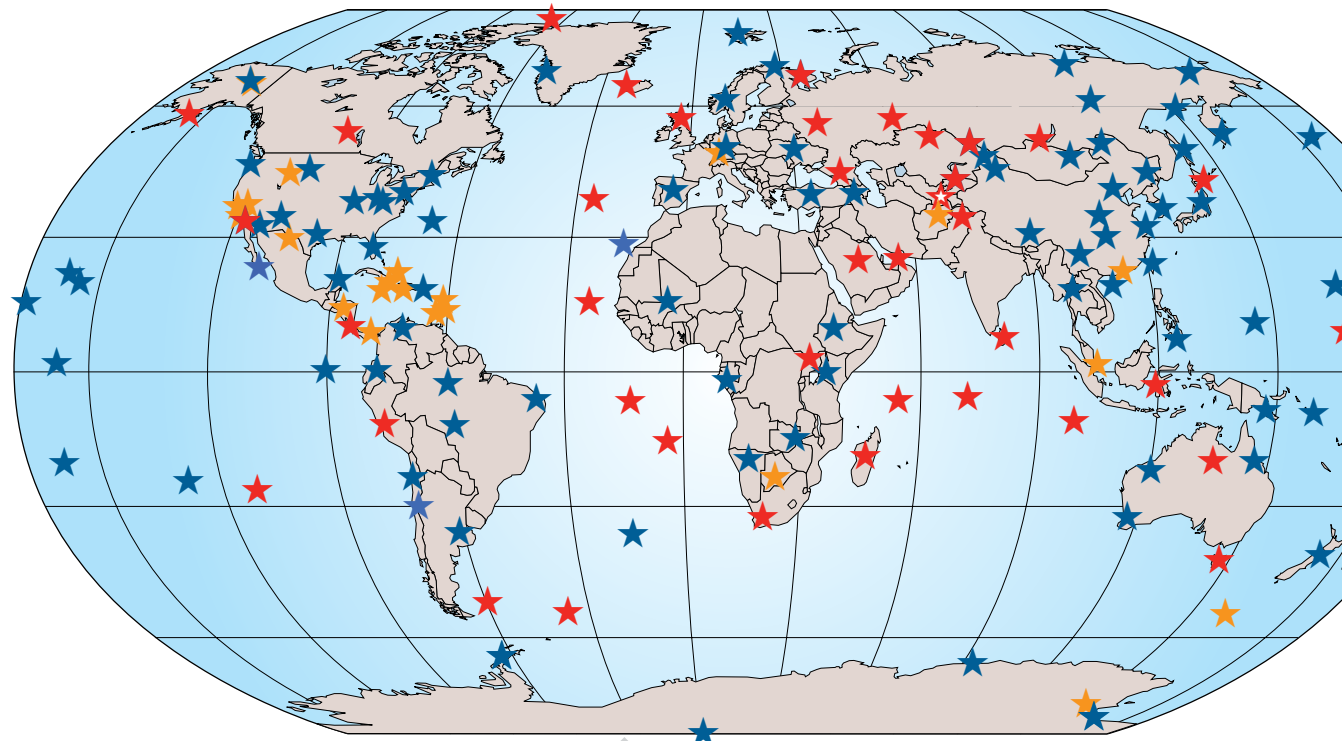
Achieving the IRIS goals has involved diversifying funding bases, collaboratively working with other agencies besides the National Science Foundation to develop and sustain the facilities, and working with hundreds of international partners to provide the global coverage and communications resources that underlie IRIS facilities.





National Security

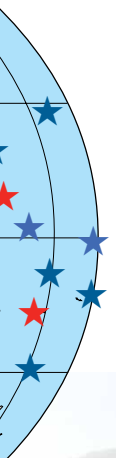
The very first nuclear test, Trinity, was relatively small and conducted aboveground, yet it generated a seismic wave strong enough to be recorded as far as 500 miles away in Tucson, AZ, by seismometers far less capable than are common today. In the decades since then, seismologists have participated in scientific and technological development to improve methods for measuring the yield and other properties of underground nuclear tests. Their work has led to an effective international monitoring system for the Comprehensive Nuclear Test Ban Treaty, has facilitated a 20-year testing moratorium among Nonproliferation Treaty-declared nuclear weapons states, and continues contributing to US national security through progressively better detection.



The current Global Seismographic Network configuration includes 80 IRIS/USGS, 41 IRIS/IDA, 10 IRIS/China-USGS, and 22 GSN Affiliates (including the USGS Caribbean Network of nine stations).

A global network of seismographic stations

In collaboration with partners around the world, IRIS has facilitated continued renewal, operation, and improvement of a global network of state-of-the-art seismographic stations that was originally facilitated by the Air Force Office of Scientific Research during the 1960s. Global Seismographic Network data quality and utility have progressively improved by taking advantage of technological developments that include digital data recording, real-time data telemetry, and feedback electronic circuits in the inertial motion sensors. The data are used to refine global seismic models, leading to more accurate assessments the location, size, and other characteristics of sources based on measurements made at great distance from any test site.



Entrance to the shallow vault of Global Seismographic Network station TRIS on Tristan da Cunha, in the South Atlantic. This station is a collaboration among the GSN, Comprehensive Nuclear Test Ban Treaty International Monitoring System, and Geoscope, the French global network of broadband seismometers.



The goal of the Teton Dam collaborative experiment was to provide near-source physics data to improve the physical understanding of how seismic waves are generated.

Recording nuclear test explosions

Research funded partly by the National Nuclear Security Administration, the Air Force Research Laboratory, and the Defense Threat Reduction Agency has used portable instruments managed by IRIS for deployments to more comprehensively record test explosions to study nonlinear source processes and to calibrate seismic propagation in regions in the vicinity of likely nuclear test sites in China, Korea, India, Pakistan, and Iran.

In 2015, IRIS partnered with the Chilean National Seismic Network (CSN) to organize a workshop in Santiago, Chile, that brought together over 100 scientists and engineers from the United States, Chile, and 15 other Latin American countries. CSN staff shared their recent experiences, and visiting participants highlighted the status of their own networks, developing a framework for future scientific and technical cooperation and data exchange.

Science Diplomacy

Science diplomacy activities promote scientific cooperation as an essential element of foreign policy. Like many Earth scientists, seismologists collaborate internationally to pursue their scientific goals, even in the face of political impediments. US-USSR seismologists continued to collaborate during the height of the Cold War and Global Seismographic Network stations were established in China during the late twentieth century. In numerous cases, exchanges of seismic data and expertise have preceded other types of improved international cooperation, much as exchanges today with Cuba, Iran, and other countries may herald wider cooperation in the future. By providing assistance in establishing global, regional, and local networks around the world, and training network operators, IRIS has helped to forge deeper ties with the worldwide scientific community.



“The collaboration between IRIS and the University of Chile during the past few years has led to significant improvement in our data acquisition and network operation practices. IRIS support has been a key factor in achieving our goals.”

— Sergio Barrientos, Director,
National Seismological Center, University of Chile



New geophysical observatories installed in Chile

A collaborative project between the University of Chile and IRIS, supported by the National Science Foundation, has established a network of 10 geophysical observatories with combined broadband seismic, strong motion, infrasound, and meteorologic sensors along the length of Chile. This 10-station deployment serves as a foundation for a new Chilean National Seismic Network, which will eventually include up to 65 additional stations. The 10 GRO-Chile stations, and several others in the new network that are installed and operating, are delivering real-time data to the IRIS Data Management Center and the USGS National Earthquake Information Center. These efforts have tremendously increased data coverage across Chile, bolstering research as well as improving tsunami early warning detection system coverage.

Station GO04 (Tololo Observatory, Chile) during its installation.



Data

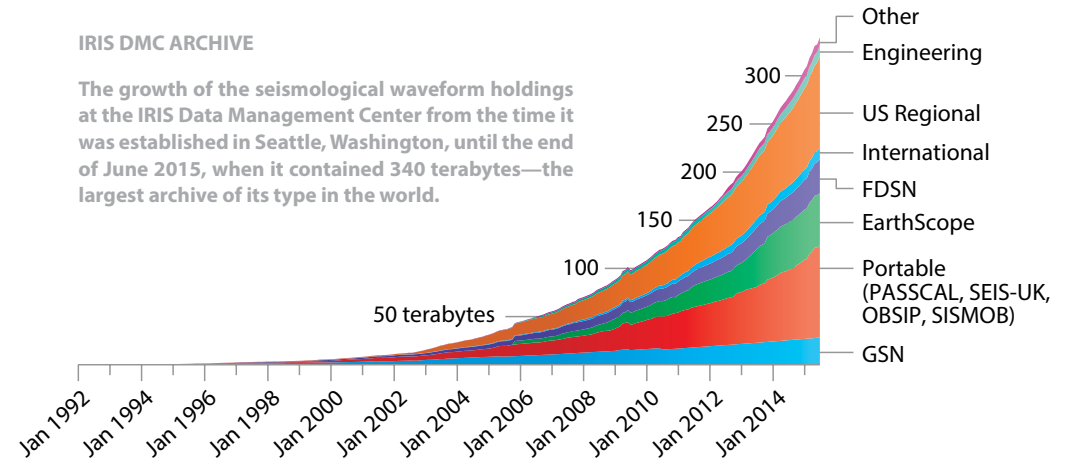
The IRIS Data Management Center manages the largest collection of freely available seismological data from passive and active source deployments in the world. Through support from the National Science Foundation and numerous collaborations with partner organizations around the world, the archive represents much of the data the international seismological community needs for research and monitoring purposes. IRIS Data Management Center holdings are made available through conventional email request mechanisms, as real-time information feeds, and through a rich suite of standardized Web services that now deliver about two-thirds of all its data.

A valuable community resource

Of greater significance than the size of the IRIS Data Management Center archive is the amount of data the scientific and monitoring communities draw from it each year. About 18 times more data are shipped from the DMC annually than the volume of new data arriving (~60 terabytes per year). The three data distribution mechanisms currently supported at the DMC include conventional email (2015 data shipments projected to be 195 terabytes), real-time (2015 data shipments projected to be 206 terabytes), and Web services (2015 data shipments projected to be 706 terabytes).

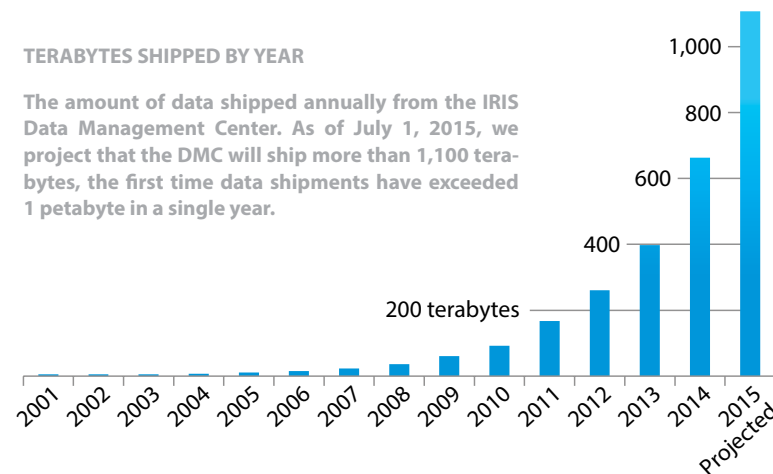
IRIS DMC ARCHIVE

The growth of the seismological waveform holdings at the IRIS Data Management Center from the time it was established in Seattle, Washington, until the end of June 2015, when it contained 340 terabytes—the largest archive of its type in the world.



TERABYTES SHIPPED BY YEAR

The amount of data shipped annually from the IRIS Data Management Center. As of July 1, 2015, we project that the DMC will ship more than 1,100 terabytes, the first time data shipments have exceeded 1 petabyte in a single year.



Data workshops

IRIS Data Services, in cooperation with the International Federation of Digital Seismograph Networks, organizes annual workshops focused on training local network operators, from South America, to Africa, to Asia, in station selection and siting and in the management of data from seismological stations. The goal is to enable open data sharing and exchange of ideas between networks in the focus area as well as with the broader global seismological community.

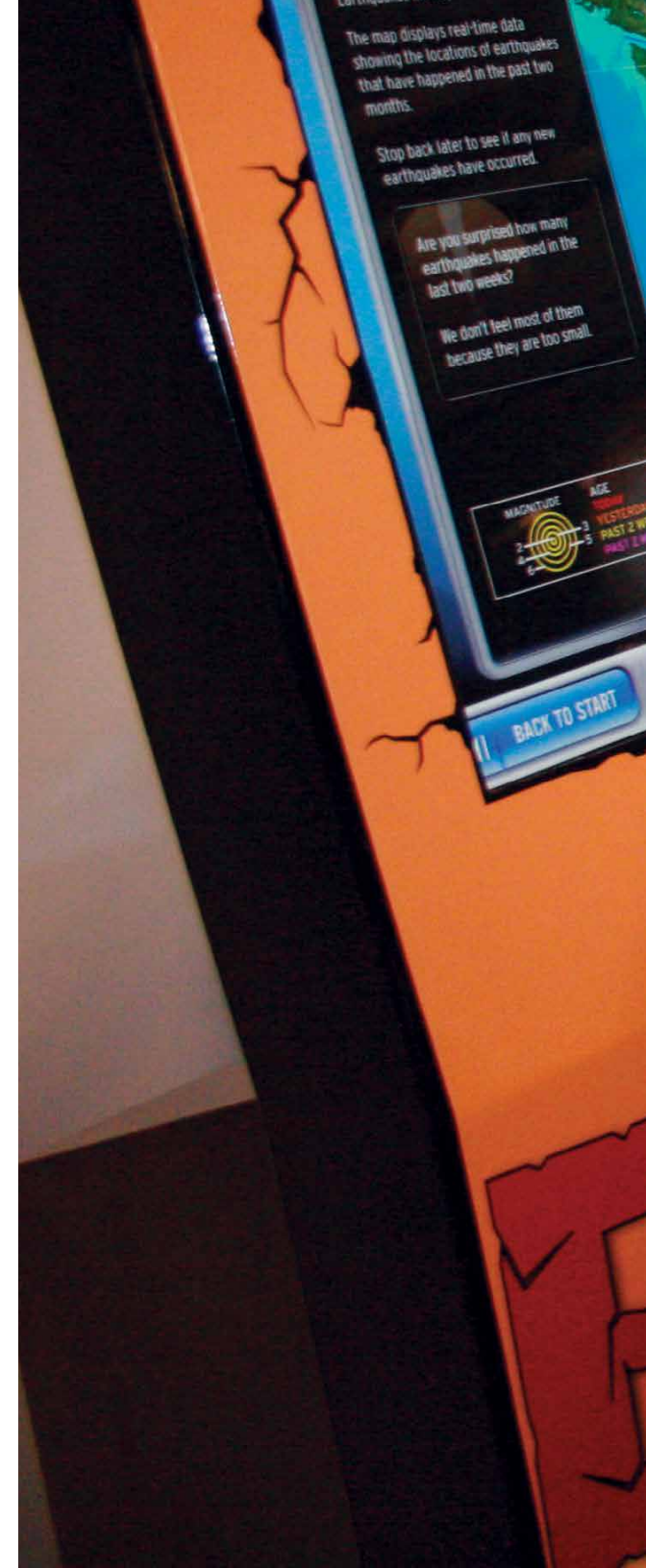
The 2014 Data Services workshop in Bogotá, Colombia, had 43 lecturers and participants drawn from 18 countries in Latin America and the Caribbean.



EDUCATE

The IRIS Education and Public Outreach program is committed to advancing awareness and understanding of seismology and geophysics, while inspiring careers in the Earth sciences. Creating a more Earth science literate public is also an important mission at Consortium member and affiliated institutions, as only a small minority of the people who participate in our programs are expected to become professionals who use Earth science in their work. In addition, IRIS leverages the resources of its research facility programs to inform students and the general public about the wide variety of benefits gained from seismological data collection and research.

IRIS Education and Public Outreach directly links the public, schools, and undergraduate institutions with the activities of the academic research community by demonstrating how basic seismological observations are made and used in Earth science investigations. Through a variety of activities that extend from providing classroom and Web resources, to creating real-time seismicity displays for millions of Web users, to development of exhibits for visitor centers and museums, to facilitating public lectures, to contributing to the development of the Earth science workforce through a highly competitive summer research program for undergraduates, IRIS encourages students to engage in scientific inquiry and appreciate the importance of the Earth sciences in their lives.





This movie shows an old style seismometer recording an earthquake. As P-waves and S-waves from the earthquake pass by, they are recorded on a seismometer using a pen.

A modern Earthquake seismometer is digital and the size of a pill-bottle cap. It is usually buried several feet below ground and can record earthquakes from around the world. The seismogram is recorded as a digital computer file.

Our Active Earth

with Irises



EARTHQUAKES

Education and Outreach

“ IRIS has played a major role in the development of my career. As a graduate student and postdoc, I took advantage of IRIS workshops, short courses, and other training opportunities. Now as a tenure-track professor, I have had the opportunity to serve on IRIS committees and mentor students through the IRIS summer intern program. Support from IRIS facilities was absolutely critical as I established my research program. ”

— Maureen D. Long, Assistant Professor,
Department of Geology and Geophysics, Yale University



Launching early career investigators

The transition from graduate student to professional scientist comes with many challenges, which may include establishing collaborations outside of their academic advisor and graduate institution and developing classroom instruction materials despite limited teacher training in graduate school. In an effort to help scientists, researchers, and educators thrive in a diverse range of career paths, IRIS organizes practical resources and professional development opportunities for early career investigators as they navigate their nascent career paths. For example, In January 2015, IRIS led the Encouraging Networks between Geoscientists And Geoscience Educators (ENGAGE) workshop in collaboration with Northern Illinois University. The workshop facilitated interactions between early career geoscientists and geo-education researchers and promoted interdisciplinary and multi-disciplinary awareness of education and research opportunities within the geosciences.

Bringing Earth science to the classroom

Earthquakes are fascinating and powerful natural events that capture the attention of students and teachers alike. The IRIS Seismographs in Schools Program serves K–16 teachers across the country and around the world by providing access to simple seismic instrumentation and to software that promotes examination of real-time seismic data in classrooms. When a seismic instrument installed in the classroom records an earthquake, students leave their desks and teachers stop mid-sentence as if the classroom beneath their feet were actually shaking! New software allows students to stream data from a selection of thousands of seismic stations around the world and to use the seismograms to locate earthquakes and conduct simple analyses.

During a training workshop, teachers learn how to operate a seismograph that they can install in their classrooms.





Facilitating summer research experiences for undergraduates

Each year, the IRIS Research Experiences for Undergraduates summer internship program exposes 11–15 students to many of the broader aspects of the geosciences and research opportunities within seismology at a pivotal part of their developing careers. Participants take part in an intensive week-long preparatory course and then work for nine to 11 weeks with seismology researchers. Research experiences often include fieldwork, and each student presents their research results at a large professional conference at some time after the summer program ends. During summer 2015, students worked with seismologists from Australia to Alaska to Connecticut, on topics ranging from determining whether earthquakes may have been induced in Texas, to investigating an inflating volcano in Bolivia, to imaging the deep Earth structure of eastern North America.

IRIS Research Experiences for Undergraduates interns learn to use seismological equipment in the field.

A frame from the 2015 Nepal Recent Earthquake Teachable Moment (RETm), one of 14 PowerPoint presentations produced in the past year. The RETms draw heavy traffic to the IRIS website where the public can investigate the full range of IRIS-based education products and acquire general information about earthquakes.

Providing timely earthquake materials

Newsworthy earthquakes can capture the attention and imagination of students, however, many instructors lack the time and/or background knowledge to synthesize available Web materials into a coherent package that tells an educational story. By delivering accurate, timely, easy-to-use resources following major ($M \geq 7$) earthquakes, the Recent Earthquake Teachable Moment presentations enhance Earth science education by expanding classroom discussion of seismology concepts and tectonic processes. The presentations are generally posted to the IRIS website within 24 hours of the event and are produced in collaboration with the University of Portland. The presentations are provided in English and Spanish.

 **Magnitude 7.8 NEPAL**
Saturday, April 25, 2015 at 06:11:26 UTC



A magnitude 7.8 earthquake occurred with an epicenter 77 km (48 miles) northwest of Kathmandu, the capital city of Nepal that is home to nearly 1.5 million inhabitants. The earthquake flattened homes, buildings and temples, causing widespread damage across the region and killing more than 2,300 and injuring more than 5,000.

Rescue workers remove debris as they search for victims of earthquake in Bhaktapur near Kathmandu, Nepal. A major earthquake shook Nepal's capital and the densely populated Kathmandu Valley before noon Saturday, causing extensive damage with toppled walls and collapsed buildings, officials said.

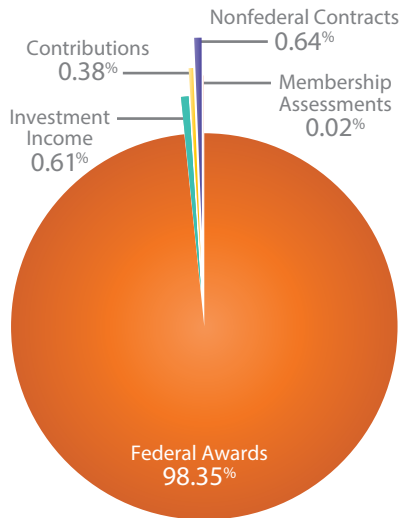
(AP Photo/Niranjan Shrestha)



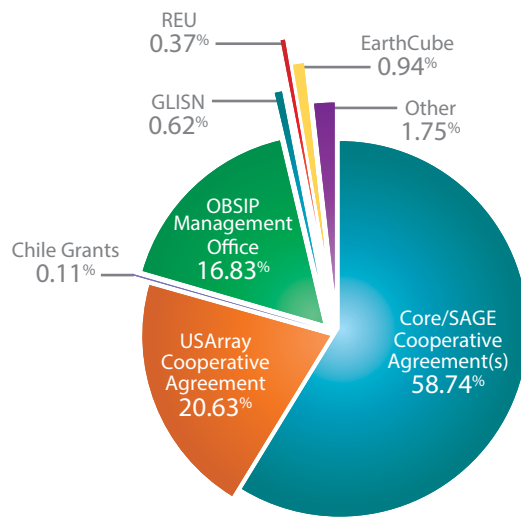
Financial Overview

Founded in 1984, the Incorporated Research Institutions for Seismology is a 501(c)(3) not-for-profit consortium of research institutions. IRIS is incorporated in the State of Delaware.

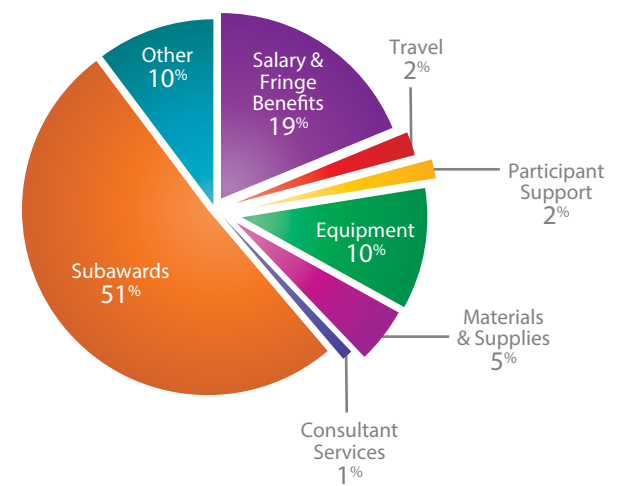
FY14 Total Revenues
\$39,128,424



FY14 Federal Award Revenues
\$38,483,648



FY14 Expenses
\$38,773,909



Expenses

In FY14, IRIS had total expenses of \$38,773,909. Over 50% of these expenses were associated with subawards. The largest go to the New Mexico Institute of Mining and Technology, which operates the PASSCAL instrument Center, the University of California, San Diego (UCSD), which maintains part of the Global Seismographic Network and operates the Array Network Facility for USArray, and Lamont-Doherty Earth Observatory, UCSD, and Woods Hole Oceanographic Institution, each of which operate ocean bottom seismometers for the IRIS-managed Ocean Bottom Seismograph Instrument Pool.

Revenues

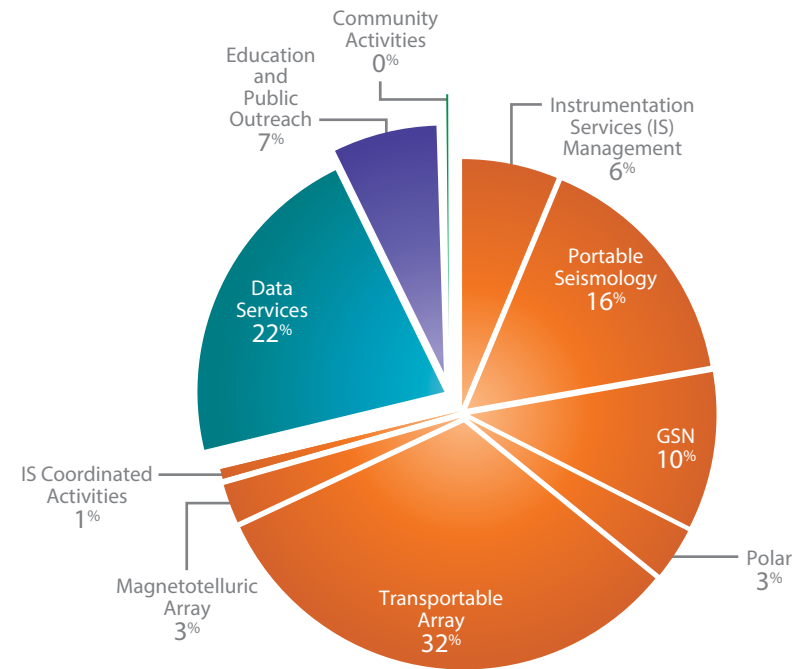
In FY14, IRIS had total revenues of \$39,128,424. More than 98% of this revenue was from the National Science Foundation. The three largest awards were the SAGE (Seismological Facilities for the Advancement of Geoscience and Earthscope) and USArray Cooperative Agreements awarded by NSF's Earth Sciences Division and the Ocean Bottom Seismograph Instrument Pool (OBSIP) Management Office Cooperative Agreement awarded BY NSF's Ocean Sciences Division.

SAGE Budget

We are currently in the second year of the SAGE Cooperative Agreement with the National Science Foundation, which is primarily funded by NSF's Earth Sciences Division. SAGE supports IRIS core programs in Instrumentation Services, Data Services, and Education and Public Outreach. SAGE also supports IRIS' EarthScope activities, including the USArray Transportable and Magnetotelluric Arrays. Funding for SAGE in Years 1 and 2 has been flat at about \$25M per year (not including supplements) and is expected to remain at this level at least through Year 3.

	Year 1 (10/2013-9/2014)	Year 2 (10/2014-9/2015)	Supplements	Cumulative (as of 7/31/15)
Instrumentation Services (IS) Management	\$1,570,355	\$1,573,814	-	\$3,144,169
Portable Seismology	\$3,992,497	\$4,010,417	-	\$8,002,914
GSN	\$2,603,621	\$2,579,834	-	\$5,183,455
Polar	\$850,000	\$850,000	\$1,276,076	\$2,976,076
Transportable Array	\$7,710,409	\$8,077,140	-	\$15,787,549
CEUSN	-	-	\$7,409,626	\$7,409,626
Magnetotelluric Array	\$642,705	\$646,781	-	\$1,289,486
IS Coordinated Activities	\$243,650	\$159,250	-	\$402,900
Data Services	\$5,432,913	\$5,402,521	-	\$10,835,434
Education and Public Outreach	\$1,655,320	\$1,704,558	-	\$3,359,878
Community Activities	\$373,530	\$120,685	\$506,244	\$1,000,459
Total	\$25,075,000	\$25,125,000	\$9,191,946	\$59,391,946
		Other		\$150,000
		Total SAGE Award Funding		\$59,541,946

SAGE Year 2 Budget by Program
\$25,125,000



A complete copy of IRIS' financial statements and auditor's reports are available from the IRIS business office by contacting admin@iris.edu.

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 Geophysical Survey of the Russian Academy of Sciences, Obninsk, Russia
 Institute of Dynamics of Geosphere, Russian Academy of Sciences,
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 University of Oxford, United Kingdom
 University of Southampton, United Kingdom
 ICSU World Data Center for Geoinformatics, Kiev, Ukraine
 University of the West Indies

THE IRIS TEAM

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Major Subcontractors

Lamont-Doherty Earth Observatory > OBSIP
New Mexico Tech > Portable Networks
Oregon State University > USArray Magnetotelluric Instruments
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