

IRIS and Earth Exploration: Facilitating discovery through Seismology

Robert Woodward¹, Robert Detrick¹, Tim Ahern¹

¹Incorporated Research Institutions for Seismology, Washington, DC 20005, woodward@iris.edu

The Incorporated Research Institutions for Seismology (IRIS) has facilitated a number of major seismology projects over the past 34 years. Examples include the Global Seismographic Network (GSN), the Portable Array Seismic Studies of the Continental Lithosphere (PASSCAL), and more recently, the EarthScope USArray program. These efforts have been characterized by deep engagement of the seismological research community in the design, specifications and guidance of these projects; attention to generating high quality data; and open access to all data collected.

IRIS is a not-for-profit consortium of over 125 US universities with graduate-level research programs in seismology and is focused on the mission of educating, facilitating, and collaborating on geophysical research. Member universities are deeply involved in guiding IRIS forward and setting the direction for how IRIS can best support Earth science research. IRIS includes over 100 foreign affiliates who share common interests with IRIS and are often the key to IRIS' international collaborations.

The GSN was established as part of the founding of IRIS in 1984. The GSN is operated in partnership with the US Geological Survey and consists of over 130 permanent, high-quality very-broad-band stations distributed around the world (Figure 1). The stations are designed to record Earth motion with maximum fidelity from thousands of seconds period to tens of Hz, from the weakest vibrations to the signals of great earthquakes. GSN data have supported fundamental Earth science as well as operational earthquake and nuclear treaty monitoring.

PASSCAL is another original cornerstone of IRIS. This program provides a pool of state-of-the-art instrumentation for individual investigators to use for their own experiments. Instrumentation includes broadband, strong motion, short period, and geophones. These sensors are used in everything from local- to regional-scale experiments. The instruments are provided to investigators at no cost, but in return the PIs share the data that are collected. In this manner data from over 1,000 experiments have been collected from every continent on the planet (Figure 2), by investigators based at both large and small institutions.

EarthScope-USArray was implemented starting in 2004. One of the signature elements of USArray is the Transportable Array, which operated a ~400 element array that rolled across the North American continent from 2004-2015 (Figure 3), and which has more recently been deployed across Alaska and parts of western Canada (Figure 4).

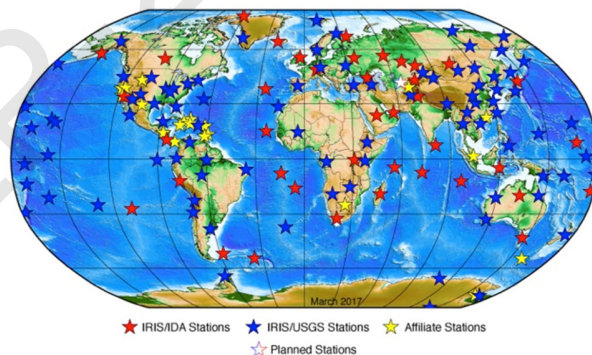


Figure 1. The Global Seismographic Network (GSN).

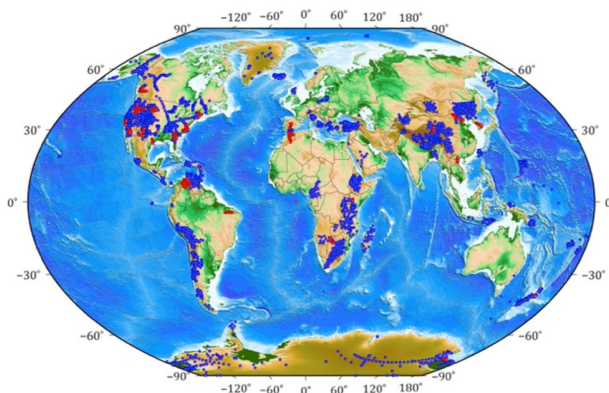


Figure 2. PASSCAL deployments since 1984.

Since IRIS' formation, data management has been a key component of IRIS' activities. All data are transmitted (more than 3,500 stations in real time) to both the IRIS Data Management Center (DMC) in Seattle. From there the data are archived, curated, and distributed via a variety of tools. More recently the DMC, in collaboration with the research community, has begun producing a wide range of data products that support seismological research. This is a key development as many of these data products require processing extraordinary amounts of data, and this "big data" effort is most readily accomplished at the data center. Another recent development is the creation of a comprehensive database of data quality metrics that have been approved by the International Federation of Digital Seismograph Networks (FDSN). FDSN data quality metrics are calculated for all seismic data managed by the DMC. These metrics assist station operators in detecting and rectifying station problems, they assist data users in identifying good and bad data, and in some cases, the quality metrics have become useful research data in their own right.

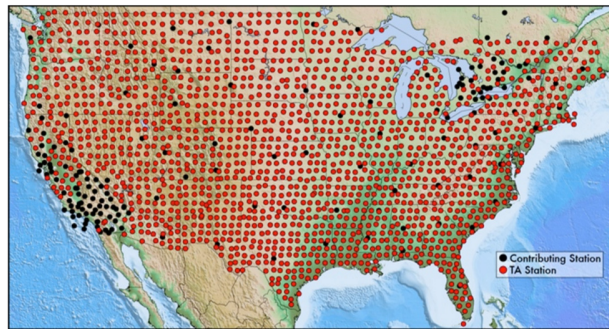


Figure 3. Map of TA in the contiguous United States. TA stations are shown in red, while pre-existing stations that contributed to the TA coverage are shown in black.

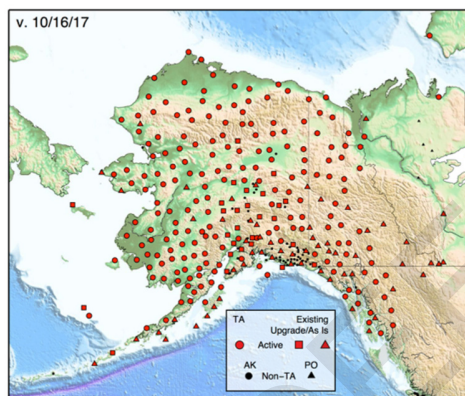


Figure 4. Map of TA in Alaska and parts of western Canada. TA stations are shown by red circles, and pre-existing stations that contribute to the TA coverage are shown in red squares and triangles. Other stations in Alaska are shown in black.

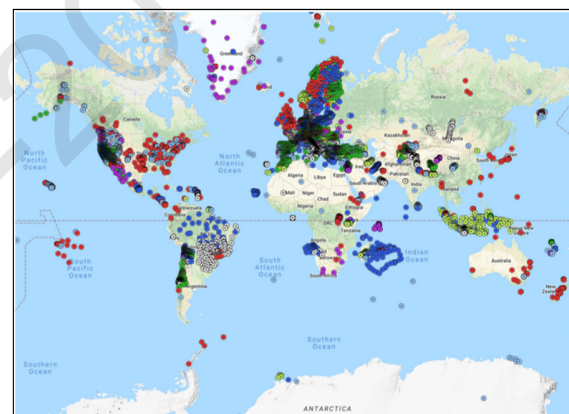


Figure 5. Map of stations available at data centers around the globe not including IRIS. The Federated approach enables scientists to have seamless access to considerably more data than are available at any single data center.

International collaboration has always been a fundamental element of the IRIS approach. Projects such as the GSN, PASSCAL, and the TA would not be possible without extensive international cooperation. In turn, the data collected in these projects have fueled research projects by investigators all over the world and have moved Earth science forward in fundamental ways. IRIS has been a strong advocate supporting international collaboration most recently through support for Federated Data Centers that enable seamless access to 10,351 permanent stations and 5,751 temporary stations held at 16 federated centers around the globe (Figure 5). As IRIS looks toward the future and potential projects like *Subduction Zone 4D* (SZ4D) it is clear these will be built around international cooperation.

This material is based upon work supported by the National Science Foundation's Seismological Facilities for the Advancement of 2 Geoscience and EarthScope (SAGE) which is a major facility fully funded by the National Science Foundation. Additional figures and more information can be found at www.usarray.org and www.iris.edu.