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# Building a Geophysical Earth Observatory for Ice-Covered Environments (GEOICE)



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## What is GEOICE?

GEOICE was an NSF-funded major research initiative to develop and build a pool of portable seismic instrumentation designed for use in ice-covered environments around the globe. The effort was the result of a collaboration between Central Washington University, New Mexico Tech, and IRIS.

The final instrument pool contains **265 sensors and digitizers**, plus associated support equipment, all designed for operation down to -40°C.

From left to right, the instrumentation includes:

- **10 Nanometrics Trillium 120 PH** broadband sensors

These broadband sensors are designed to record very low frequency signals, and are flat to velocity from 120 s to 150 Hz.

- **55 Nanometrics Trillium Compact PH** sensors

These compact broadband sensors are designed to record signals that range between ~50 s and ~100 Hz.

- **200 MagSeis Fairfield 3C Zland nodal** sensors

These small, all-in-one sensors combine a 3-component sensor with onboard digitizer, GPS, batteries, data storage, and are intended for recording signals from ~5 to 500 Hz.

- **65 Nanometrics Centaur digitizers** (not pictured)

These rugged polar-rated digitizers pair with the 120PH and Compact PH broadbands and can record up to 64 GB of data on a removable SD storage card.



The GEOICE sensor pool: Nanometrics 120PH (left), Nanometrics Compact (center), and MagSeis Fairfield Zland node (right). Photo by Derry Webb

## Why was it built?

Earth's ice-covered regions are undergoing rapid change in a warming climate. Increasingly, seismic methods are being used to observe and characterize these changes. Unfortunately, these same regions are often remote and logistically difficult (and expensive) to operate in. To overcome these challenges, the GEOICE instrumentation was purpose-built for ice-covered environments, including extreme cold, warm-season melting, and extended periods without solar power--all in the service of **accomplishing more science at reduced cost.**

Key features of the instrument pool include:

- A mixed suite of instrumentation designed to make **observations of the complete seismic wave-field across spatial scales and frequencies**, while minimizing aliasing.

- The system was built with polar logistics in mind, resulting in instrumentation that is **smaller, lighter, and requires less power** than existing polar instrumentation and is suitable for deployment in the most demanding polar environments.

- Individual **users can select the precise mix of instruments** (up to and including the entire pool) to suit the needs of their particular deployments.



A GEOICE test deployment in Antarctica. Photo by Paul Winberry

## Who is it for?

The science enabled by the GEOICE system **cuts across many disciplinary boundaries** and we expect significant usage of these instruments outside of the traditional seismologic community.

GEOICE provides a suite of tools for geoscientists to use in studying a variety of phenomena in ice-covered regions, recording signals from the solid Earth, glacier movement, liquid water flow, and other relevant signals. Thus, these instruments can be a key tool for making **observations of the interaction of the solid Earth with the cryosphere and atmosphere** to understand better how drivers such as climate change impacts these systems.



A Compact PH during installation in Antarctica. Photo by Paul Winberry



Installing a Zland node in Antarctica. Photo by Akram Mostafanejad

## How can you use it?

The GEOICE instruments are part of the **open-access equipment pool** as part of the SAGE facility (operated by IRIS out of the PASSCAL Instrument Center at New Mexico Tech). The instrumentation is **available at no cost to any investigator** provided they are willing to abide by the IRIS/SAGE usage policies (priorities given to NSF funded experiments). All data collected with GEOICE instruments will be archived and made freely available through the IRIS Data Management Center (another SAGE facility). Those interested in learning more about the GEOICE project, including how to request usage of this or any other PASSCAL facility instrumentation, may visit:

[passcal.nmt.edu/content/geoice](http://passcal.nmt.edu/content/geoice)



The PASSCAL Instrument Center on the New Mexico Tech campus. Photo by Derry Webb

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