# Penn State researcher develops new seismometer for studying ice sheets

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Sridhar Anandakrishnan in a plane on his way to Antarctica. Credit: Sridhar Anandakrishnan

On a cloudy day in Antarctica, it's impossible to see the snow. With the sunlight diffused behind the clouds, there are no shadows and even tall drifts are invisible in the endless sea of white. Researchers here use bamboo poles to mark their path and to help orient themselves as they tread the ice sheet, looking for clues about how climate has changed over time.

Sridhar Anandakrishnan, a Penn State geoscience professor, is part of a team of university researchers that travels to Antarctica and Greenland to study what the ice sheets can reveal about climate change. He's also using some of the latest information technologies to develop a new type of seismometer, a device that measures the way seismic waves move through the ice. The results form a picture of how the ice sheet is layered and, like the rings of a tree, can show the ice sheet's history.

"Over time, layers are formed when snow accumulates and compresses or when ice melts and runs into the ocean," Anandakrishnan explained. "By studying these layers, we can see how the ice sheets have evolved and pick up on trends that correlate with climate change."

The ice sheets are vast, stretching for miles in every direction. When the research group steps off the plane, they stand on ice two miles thick, comprised of thousands of built-up layers. But without seismometers, it would be impossible to see them, and five years ago Anandakrishnan came up with his idea for a type of seismometer that was completely wireless.

Now, he's working on the final prototype, which he affectionately calls a "geoPebble." Unlike other models, the geoPebbles are small, compact and completely self-contained. They require no cables or power cords of any kind.

"I had the vision for geoPebbles several years ago, but the technology wasn't quite there yet," he explained. "It's only recently that it has caught up to what we wanted to accomplish. There's a huge opportunity in the field of geosciences for IT specialists to come in and help us develop these new technologies."

The geoPebbles are hexagon-shaped, about nine inches high and the diameter of a large dinner plate. A rectangular battery fills most of the interior, with sensors fitting on either side. A circuit-board fits on top, followed by the lid. Anandakrishnan described them as laptops without screens; they're equipped with WiFi and don't have to be plugged in. They even charge wirelessly.

The wireless feature was integral to Anandakrishnan's vision. Antarctica can be pleasant when it's sunny, but when the clouds and wind come out, it can be miserable, he said.

"It's the wind that makes it really tough. When that happens, you have to layer on your jackets, huddle in your tent and just wait for it to be over," he explained. "Because of the harsh environment, we need to have technology that is very resilient. Eliminating cables and wires helps because those are typically the components that fail first."

Once the prototype is finalized, the team will ship the geoPebbles to the research site, where they will strategically place more than 100 on the ice. Seismic waves need to be created in order to be measured, so buried explosives and blows from a sledgehammer create the energy that will move through the ice sheet. The geoPebbles will stay on the surface for up to 10 days to record the waves' behavior.

Anandakrishnan said he wouldn't have been able to succeed without the help of his colleagues. Made up of fellow faculty members and dedicated students, the team collaborated on everything from the geoPebble design elements to programming the software to figuring out how to use the data after it's collected.

But gathering large amounts of data is only useful if it can be analyzed, so Dave Pollard, a research professor with Penn State's Earth and Environmental Systems Institute, takes the information collected by the geoPebbles and plugs it into a computer for a process called ice-flow modeling. This process allows scientists to track how quickly the glaciers are melting and forecast the speed at which they'll continue.

"The data gathered from the geoPebbles encapsulates mathematically everything we know about these ice sheets," Anandakrishnan explained. "When we enter it into our computer models, we can do something called 'run it forward,' which means we ask the system to make predictions based on trends it sees in the collected data. It's similar to a weather report; the more information you can put into it, the better its predictions will be."

Students also have played an important role in the geoPebble project. Aaron Fleishman, a Penn State graduate student, has been involved since January 2012 and has helped with much of the programming of the device.

"It was great being a part of a project like this that will actually go on to be an enduring finished product," Fleishman said. "To see the geoPebble go from being a 3-D model on a computer screen, evolve through the trial and error process of designing it and eventually turn into a finalized prototype has been an amazing learning experience."

Fleishman pointed out the irony of one design element of the geoPebbles in particular—the team had to mold them out of white plastic, even though they were being made to rest on sheets of snow and ice. He explained that adding dye to the plastic would compromise its integrity and lower its resiliency.

If needed, the researchers could add colored webbing to the lids of the geoPebbles to make them easier to see. But even if the seismometers are difficult to spot on Antarctica's icy surface, it's what they help us see under it that's really important.

Provided by Pennsylvania State University