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Not My Fault: Of nodes, broadbands, and dark fiber

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A very exciting experiment is currently underway. If you live in Humboldt County, it is practically beneath your feet. The experiment began on May 18 when a DAS interrogator was hooked up to a section of the optic cable that runs between Arcata and Eureka. The purpose of the experiment is to figure out how optic fibers respond to the passage of seismic waves and how these signals can be utilized to determine earthquake characteristics.

Everyone in Humboldt County has experienced construction delays associated with the laying of underground optic fiber cables. When completed, these cable lines will launch us to the head of the line in terms of internet speed and bandwidth. A number of sections have been completed, but until the entire system is completed, they will remain silent.

Well not entirely silent. It is one of these completed but unused segments that has provided a unique opportunity for seismic experimentation. The line runs from Arcata past Arcata City Hall, down 7th and over to Union where it meets Old Arcata Road and continues south becoming Myrtle Avenue and ending up just before Redwood Acres Fair Grounds. There is nothing you can see; the optic fiber is in a conduit buried beneath the surface.

You may have heard about the offshore optic cable installation connecting us to Singapore, Taiwan, and other Pacific destinations (Times-Standard 3/31/21). I hope we can piggyback seismic data gathering on those cables once they are completed. But the local broad-band improvement project has provided an opportunity to learn what the fiber seismic data means, a first step to offshore application.

Seismologists are always looking for ways to acquire earthquake data – especially in inaccessible areas like ocean basins. I wrote about the promise of ocean cables a little over a year ago (Not My Fault 4/18/21) when the trans-Pacific cables were still in the planning stage. I had just learned about Distributed Acoustic Sensing (DAS) as a possible seismic tool and quickly became part of an ad hoc group to explore the possibilities of applying it to the North Coast Region.

Unlike traditional seismographs that measure the velocity or acceleration of the ground in one particular spot, DAS measures minute deformations of the cable. A DAS interrogator is a file-cabinet sized instrument box that sends a coherent laser pulse along a single strand of the cable. A small proportion of the laser energy is reflected back. The interrogator measures the time between the pulse and the reflection. The system is sensitive enough to detect the tiny changes in reflection times caused by stretching and compression as seismic waves cross the cable.

It is hard to wrap one's head around how tiny these signals area and how much data is collected. The interrogator sends thousands of tiny pulses along the cable every second. Algorithms can track pulse-reflection pairs coming from different parts of the cable so that it can effectively locate disturbances along small sections – 100 to 200 feet in area – acting like a string of seismographs. At least that's what we think. There have been a number of studies in the past several years that have convinced me of the promise of the method.

Enter the Humboldt experiment and kudos to some special people who made it happen. It began in February 2021 with an email from Bob McPherson about a proposed trans-Pacific cable off of the Samoa Peninsula. Bob had been on the Grand Jury and kept abreast of development on the Peninsula. That was quickly followed by several ZOOM calls with Harbor District, optic fiber companies, government agencies and a number of Research 1 University representatives.

Each call had more participants and interest snowballed. But the most important person to come into the picture was not a seismologist. Bob learned that HSU (before it became Cal Poly) had made broad-band infrastructure a high priority and that President Jackson had his Special Assistant Connie Stewart working with cable companies and the giants of the communication industry.

Anyone who has lived in the Arcata area for a decade or more knows Connie Stewart. For years I would nod in passing as we held adjacent but unrelated meetings at Brio. Connie has a well-earned reputation for getting things done and I can now say Amen to that. Connie knew all the partners in the onshore and offshore cable projects and proposals. She wanted Humboldt to be a player and she was looking for projects that would trigger cutting edge research and collaboration.

DAS requires access to an unused strand of cable. We can't send those laser pulses down a line that is being used for data transfer and communication. Unused strands are called dark fiber. Connie suggested that we could use one of the completed cable sections that wasn't yet hooked up for active duty. And she knew just the spot. Why not use the eight miles of cable that were in the ground along Old Arcata Road and Myrtle?

Jeff McGuire, research seismologist at the USGS, had been looking for a place to demonstrate the effectiveness of DAS technology and he jumped at Connie's invitation. Why not set up a two-month experiment, connect a DAS interrogator to one end of the completed cable and cover the area with conventional seismographs so we can relate the DAS signals to what we already understand – a DAS Rosetta stone.

And that is what is happening right now. Forty-eight nodes (thermos-sized geophones) have been buried along the side of the cable route. Four state-of-the-art broad-band seismographs have also been deployed at the ends and near the middle of the cable line. With all of this instrumentation, seismologists will finally be able to say exactly what the DAS signals mean.

Only half of the nodes were in when the system caught its first quake – a 3.1 near Ferndale on May 20. Six days later, the cable got a lovely recording of the 7.2 from Peru. Just these two events alone have provided ample data to make the experiment worthwhile. And who knows what we will catch in the seven remaining weeks? I'm hoping for moderate – not too big, please.

Lori Dengler is an emeritus professor of geology at Humboldt State University, an expert in tsunami and earthquake hazards. The opinions expressed are hers and not the Times-Standard's. All Not My Fault columns are archived online at https://kamome.humboldt.edu/resources and may be reused for educational purposes. Leave a message at (707) 826-6019 or email rctwg@humboldt.edu for questions and comments about this column, or to request a free copy of the North Coast preparedness magazine "Living on Shaky Ground."