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Not My Fault: Of deep-sea cables, earthquakes and tsunamis

Lori Dengler/For the Times-Standard
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An advantage of COVID times is the ability to “attend” meetings that used to require travel. Two months ago I listened to a Berkeley Seismology Lab seminar by Zhongwen Zhan, an Assistant Professor of Geophysics at Cal Tech. Zhongwen is at the cutting edge of a new breed of seismologists who are using submarine cables to collect seismic information from areas hitherto inaccessible.

This was new to me. I thought satellites were the main conduits of data transportation in our information age. Wrong. More than 95% of intercontinental communication is via the 80 million miles of cable lying on the sea floor. I have been using them while putting this column together. If you have ever used the internet, social media or made an on-line purchase, you have used them too.

Ocean cables have been in use far longer than you might think. Telegraphs became operational early in the 19th century and groups began working on how to lay cables on the sea floor soon after. The challenges were significant - insulating the conducting wires in the ocean environment and driving signals along great distances. Mid-19th century saw the first successful cable between the British Isles and Europe. A transatlantic cable became operational in 1866, and India was connected to the Middle East in 1870. By 1906 cables connected the North America to Japan, Hawaii, Australia, New Zealand and other areas of Oceania.

Several features of these earliest cable systems remain today. They were laid across the seafloor by specially adapted ships and both the ships and cables were privately owned. It was commerce that drove development and installation then and now. Cable technology proved an enormous value to business with ships able to deliver goods and receive orders for the next port in minutes rather than days or weeks. Cables were to play a role in warfare too; severing enemy cables and protecting your own became tactics in both world wars.

The telegraph cables of the early to mid- 20th century had many problems. Repeaters were yet to be invented. Very high voltages were needed to overcome the resistance of the great cable lengths causing distorted signals. The single conductive path meant only one signal at a time could travel in either direction, limiting transmission rates to 10 to 12 words per minute. Post WWII saw a boom in technical innovation with repeaters and coaxial cables, providing the wider bandwidth needed for telephone.

The modern cable era began in the 1980s with optical fibers capable of carrying information at the speed of light. Today’s cable is a complex bundle of six to twenty pairs of fibers, surrounded by petroleum jelly, more protective layers, stranded steel wires, and Mylar tape all coated in polyethylene. It can transmit terabytes of information every second – enough bandwidth to carry more than 100 million telephone calls at the same time.

Cables are vulnerable to natural hazards. The 1929 Grand Banks tsunami provides an illustration. An earthquake south of Newfoundland was followed by a tsunami of over 30 feet. Forty villages in southern Newfoundland were flooded and 28 people died. Why was the tsunami so large? The triggering earthquake was M7.2, too small to explain the tsunami size. Submarine cables provided an important clue – snapping in 12 places soon after the earthquake. The conclusion: shaking triggered a landslide along the continental slope breaking the cable. Both the earthquake and slide contributed to the size of the tsunami.

Natural hazards, however, are not the biggest threat to cables. Trawling accounts for 40% of submarine cable faults worldwide. The second largest problem is anchoring near cable lines. Most cable lines are now buried in shallower waters near the coast where human disturbance is most likely.

My newfound interest in submarine cables is their potential to not only transport information but provide it as well. Seventy percent of the planet is covered by water, inaccessible to direct observation and instrumentation. The majority of earthquakes occur beneath the sea floor. Zhongwen’s talk introduced me to cable seismology – new techniques where the cables become instruments.

Distributed Acoustic Sensing (DAS), uses dark fiber (unused optical fibers in the cable) to measure the speed of seismic waves along the cable transect. Fault movement stretches or compresses the cable length causing measurable changes in wave speed. The location of the cable wave anomalies provides a way to determine epicenters. A disadvantage of DAS is that you need access to unused optic fibers and commercial owners of the cables don't usually have extra cable space to devote to science.

The newest technique piggybacks the science onto an already working optic strand. Anyone wearing polaroid glass knows about polarization, light vibrating in one plane. The light in the optic fibers is also polarized – it helps cable owners to send multiple beams at the same time. If the cable is undisturbed, polarization won't change from where it enters to its exit. But if an earthquake occurs, the polarization will change. Zhongwen's team has developed algorithms that measure the changes and help to constrain where the earthquake occurred.

Have you heard about the new submarine cable that will connect Eureka to Singapore (Times-Standard 4/1/21)? Many see this as an opportunity for Humboldt County to become a leader in internet connectivity; I think it is a potential boon to a better understanding of our offshore tectonic environment.

Most of our earthquakes are offshore. What if we could find a dark fiber to start collecting epicenter information, or grab the polarity information to pinpoint an offshore rupture? It might give us a vital few extra seconds for Earthquake Early Warning and maybe even a few moments additional time for tsunami alerts. It could also provide critical information on the marine environment for oceanographers. To my mind it's a no-brainer. Submarine cables are here to stay so let's get as much useful science out of them as we can.

Note: Much in today's column was gleaned from https://en.wikipedia.org/wiki/Submarine_communications_cable .
Learn more about seismology and deep-sea cables at https://news.berkeley.edu/2019/11/28/underwater-telecom-cables-make-superb-seismic-network/ and https://www.caltech.edu/about/news/using-submarine-cables-to-detect-earthquakes

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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://www2.humboldt.edu/kamome/resources and may be reused for educational purposes. Leave a message at (707) 826-6019 or email Kamome@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."