Times Standard

Not My Fault: Secrets in the mud: Cores to Code debuts at Humboldt

Lori Dengler for the Times-Standard
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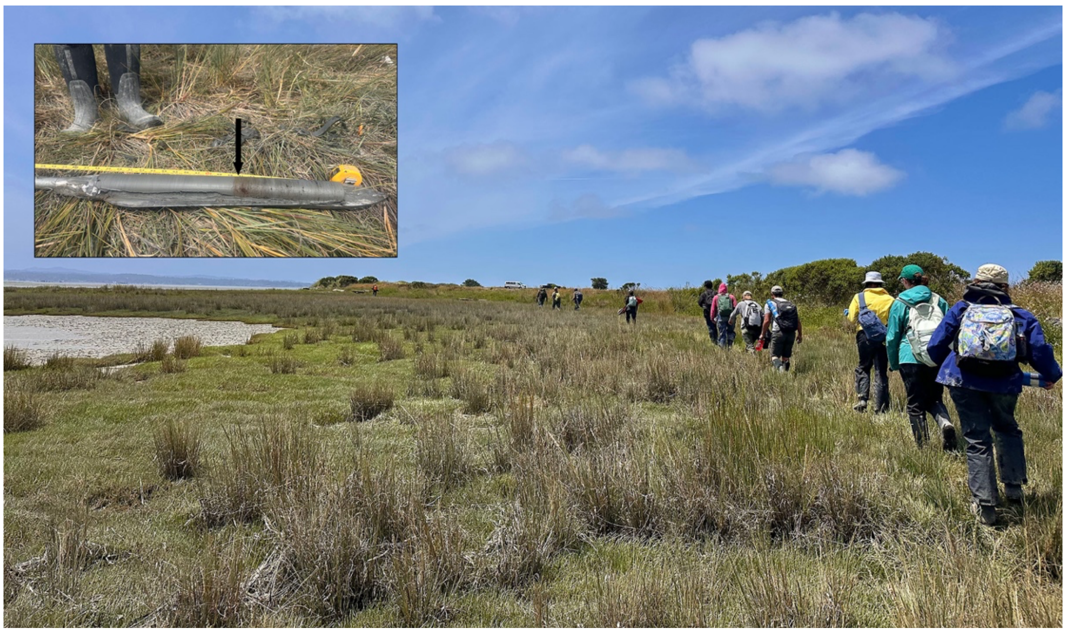

Students in CRESCENT'S Cores to Code program at McDaniels Slough at the edge of Arcata Bay. Inset shows one of the cores the group extracted, arrow points to the buried peat layer that was likely submerged in a great earthquake when the bay suddenly deepened (photo T. Dura).

Something wonderful is happening in the Geology Department at Cal Poly Humboldt right now. Ten undergraduate students from around the country are busy working with microscopes to pick out and identify tiny critters that will help to pin down past Cascadia earthquakes. They are participating in the inaugural Cores to Code program of the Cascadia Region Earthquake Science Center (CRESCENT).

I wrote about CRESCENT after attending the first meeting of the Center (11/4/2023). The National Science Foundation had just awarded a consortium of 16 universities a five-year grant to establish a center to prioritize the most important questions, support studies to provide answers, and engage regional partners that will result in societal actions to reduce impacts from the next Cascadia earthquake. There are three "legs" to the CRESCENT project: fundamental research, engaging partners in fields like urban planning and emergency management who can apply this research to societal resilience, and earth-science workforce development.

The cohort of students at Humboldt this week are an important part of the workforce development leg. Nationwide, the earth sciences have lagged behind other STEM disciplines in growth, especially in attracting students from rural and other underserved communities. The Cores to Code program is targeted at these demographics by offering a fully paid three-week program exposing undergraduates to fieldwork and emphasizing its societal relevance.

I admit to being slightly envious of what these ten students are experiencing in the Cores to Code program. They assembled at the University of Oregon in Eugene two weeks ago and got a firsthand introduction to the Cascadia region and the earthquake threat from some of the top researchers in the world. They spent the next two days driving the coastal route to Humboldt with a chance to see some of the communities at threat of a Cascadia earthquake and tsunami.

Last week they got their hands dirty. They spent three days taking sediment samples at McDaniel Slough in Arcata Bay. Why sediment samples and this location? We don't have a long written history and sediments are the only direct evidence of past earthquakes and tsunamis that happened hundreds to thousands of years ago.

Recent great quakes in Indonesia, Chile, and Japan give a good picture of what to expect when earthquakes in the upper *M8* to lower *M9* range occur. The coastal land level changes, sometimes dropping the ground several feet below the current tidal zone. Trained eyes can decipher tortured sediment patterns of liquefaction-induced strong shaking. Tsunami sand deposits may blanket the coastal sediments.

Bays and estuaries are always receiving sediment input from storms and more frequent coastal processes. How can we distinguish earthquake and tsunami inputs from other causes? Enter biology. Marshes and tidal flats are unique ecosystems that have adapted to the current tidal level. Plants and animals have carved out niches where they can flourish. March plants like Triglochin and Distichlis inhabit the lower salt marsh surface while the rare Grindelia with its lovely yellow flowers prefers the higher edges with less frequent exposure to salty water.

The current marsh surface is readily defined by a few inch thick peaty mass of stems and decayed plant material. Below the peaty zone, the muds and silt appear to the naked eye to be lifeless but pull out your microscope and a whole world of microfossils emerges. Diatoms and foraminifera have, like the tidal plant community, adapted to very specific environments and fortunately their unique "shells" of silica, calcium carbonate, or agglutinated sediment can pinpoint exactly what sort of place they lived in.

I had a small introduction to microfossils as an undergraduate, but it wasn't until my third year of teaching at Humboldt that I became slightly better acquainted. I had teamed up with a biology professor to acquire the first scanning electron microscope (SEM) on campus and taught an SEM class in the spring of 1981. One of the students was Eileen Hemphill-Haley who chose a project on diatoms.

Diatoms are single-celled organisms that live in any wet or damp place on the planet. The cell wall (frustule) is made of silica and settles into the seafloor or other sediment after their typical 6-day lifespan. There are an enormous number of diatoms on the planet, and you can thank them for providing between 20 to 50% of the oxygen you breathe. It would be hard to find any sediments on earth that don't contain their remains.

Eileen's microphotographs were beautiful. Of the roughly 100,000 known species of diatoms, each has a unique frustule that looks like a tiny opaline gem. Some are disc shaped, others blocky or look like rods. Eileen's project was to identify whether they came from fresh, marine or brackish water. Diatoms can even tell you whether the sediment came from deep or shallow water or if they preferred the wave-wash zone. A "diatom test" is sometimes given to drowning victims in forensic studies to determine where they died.

Eileen rarely uses an SEM to study diatoms anymore, it's much more efficient to use a high-quality light microscope. But I like to think that her SEM class project so many years ago helped nudge her to a PhD and a trail-blazing career applying diatoms to the study of earthquakes and tsunamis. She teamed up with Brian Atwater of the USGS to distinguish potential tsunami deposits from other sources and In 2000, their work was recognized with the Kirk Bryant Award, the highest accolade in the field of geomorphology.

Many people have applied the study of diatoms and their cousins, foraminifera, to earthquake studies since then, including Tina Dura and Andrea Hawkes, two of the faculty leading the Cores to Code program. Tina was recently the lead author on a paper published in the Proceedings of the National Academy of Sciences (4/28/2025) on coastal land-level changes after a great Cascadia earthquake largely based on studies of microfossils and Andrea uses foraminifera and geochemistry in her coastal processes and tsunami research.

I visited the Cores to Code students on Thursday. One group were busy with Tina examining diatoms under the microscope and the second half were examining foraminifera with Andrea. The data was incorporated into stratigraphic columns mapping out relative tidal levels of the Bay. They were surprised by the wealth of information these creatures contained.

It's not all field and laboratory work for the group. On Friday, Harvey Kelsey the third faculty member, arranged for the group to meet with local planners and earthquake professionals on how this work might impact the local community. This is the "code" part of the program. We are a ways from establishing regulations for potential earthquake subsidence, but the meeting gave students the chance to hear how their work fits into the bigger community resilience picture. Linda Nellist, coordinator for the County CERT program told me how impressed she was with "their curiosity about how their future work could be useful to the population living with the earthquake/tsunami hazards. "

The Cores to Code group may be modest in number but I expect their experiences in Humboldt County will spread to fellow students and teachers when they return home. I look forward to learning what they accomplish as they become the next generation of earthquake professionals.

Lori Dengler is an emeritus professor of geology at Cal Poly Humboldt, and 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/taxonomy/term/5 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 copies of the preparedness magazine "Living on Shaky Ground."