UC SANTA BARBARA

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Sea Change

With one of the highest-quality climate and environmental archives in the world's oceans, the Santa Barbara Basin presents the ideal natural laboratory for researchers studying the global climate record on a variety of time scales, from last year to a million years ago. That's according to UC Santa Barbara geologist James Kennett.

Exploring this data-rich area off the coast of Southern California, Kennett and his colleagues at UC Davis and the San Francisco-based California Academy of Sciences found that abrupt climate changes caused small decreases in seawater oxygenation that in turn led to extensive seafloor ecosystem reorganizations. What's more, recovery from these reorganizations took up to 1,000 years.

Their study, which appears today in the online Early Edition of the Proceedings of the National Academy of Sciences, is the first to quantitatively examine broad ecosystem responses in the deep-sea sediment record.

"We were surprised to learn that this microfossil record is richer and more useful than first expected," said co-author Kennett, professor emeritus of earth and marine science. "As a result, we were able to test the response time of different members of the bottom-dwelling ecosystem to both abrupt warming and cooling episodes. We were also surprised to discover just how long some took to recover."

The research team analyzed more than 5,400 invertebrate microfossils — including sea urchins, clams, snails and crustaceans — from the offshore Santa Barbara

sample. The sediment core — essentially a tube of material that covers a period between 3,400 and 16,100 years ago — provided a before-and-after snapshot of what happened during the global warming that occurred at the end of the last glacial period. This was a time of abrupt climate warming, melting polar ice caps and expansion of low oxygen zones in the ocean. The new study documents how long it took for ecosystems to begin the process of recovering from such a dramatic episode of climate change.

“These past events show us how sensitive ecosystems are to changes in Earth’s climate; it commits us to thousands of years of recovery,” said lead author Sarah Moffitt, a postdoctoral scholar at UC Davis in its Bodega Marine Laboratory and its Coastal and Marine Sciences Institute.

“Our analysis demonstrates that ocean sediments harbor metazoan fossil material that can be used to reconstruct the response of seafloor biodiversity to global-scale climate events,” Kennett explained. “We show that the last deglaciation — the most recent episode of climate warming — was accompanied by abrupt reorganizations of continental margin seafloor ecosystems through expansions and contractions of the subsurface low-oxygen zones.”

The history lesson told by the sediment core is one of initially abundant, diverse and well-oxygenated seafloor ecosystems, followed by a period of warming and oxygen loss in the oceans and then by a rapid loss of diversity. In fact, microfossils nearly disappeared from the record during those times of low oxygen.

The researchers found that oceanic oxygen levels fell by between 0.5 and 1.5 mL/L over a period of less than 100 years, demonstrating that relatively minor changes in oxygen levels could result in dramatic shifts and reorganizations for seafloor communities. Kennett noted that these results suggest that future global climate change may result in ecosystem-level effects with millennial-scale recovery periods.

“It shows us what we’re doing now is a long-term shift; there’s not a recovery we have to look forward to in my lifetime or my grandchildren’s lifetime,” said Moffitt. “It’s a gritty reality we need to face as scientists and people who care about the natural world and who make decisions about the natural world.”

The research was funded by the National Science Foundation as well as the University of California Multicampus Research Programs and Initiatives.

About UC Santa Barbara

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