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MICROBES IN OXYGEN MINIMUM ZONES

FKt240412 | #OxygenMinimumMicrobes

Image credit: Schmidt Ocean Institute

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Eastern Tropical Pacific Oxygen Minimum Zone of Chile

Chief Scientist: Dr. Maria Pachiadaki, Woods Hole Oceanographic Institution, U.S.

34 science days | **3,744** square kilometers mapped | **153** CTD & rosette casts | **0.1** terabytes of data collected

EXPEDITION OBJECTIVES INCLUDE:

- Addressing significant gaps in knowledge of low oxygen regions by applying *in situ* sampling approaches to accurately measure rates of microbiological processes and community structure.
- Testing and implementing new technology to collect and process samples, avoiding contamination as they move from low oxygen to oxygen-rich environments.
- Revealing the genomic blueprint of active single cells involved in these processes.

Oxygen Minimum Zones, or OMZs, extend from 100 to 1000 meters in depth and are areas with persistent layers in the water column that have low oxygen concentrations due to biological, chemical, and physical processes. These anoxic waters can be inhospitable to most large animals, yet microbes have adapted to live and thrive in this oxygen-starved environment. Microscopic organisms living in OMZs are diverse and immense, yet the data on their life cycles and role in the Ocean's biogeochemistry is scarce. Understanding the functions and activities of microbial communities in these regions is critical, as OMZs are thought to be expanding in size due to climate change.

Aside from physiological changes induced by pressure and temperature shifts during sample recovery, oxygen contamination can alter samples. Oxygen easily diffuses through the plastic and rubber components of sampling devices and experimental setups — even with careful handling and rigorous flushing of containers, shipboard experiments are likely generating incorrect estimates of process rates because the samples are contaminated with oxygen during the collection process. Preserving samples *in situ* before they move through areas where they can be contaminated is essential for an accurate portrait of the processes taking place in OMZs.

To address this contamination problem, an international team of scientists applied multiple custom-built technologies designed to sample in the OMZ in the Eastern Tropical Pacific off northern Chile, the second largest known low-oxygen region on Earth. Using a mini trace analyzer *in situ* logger, or mTail, the team found sporadic pockets of water with trace amounts of oxygen present, in an area where oxygen levels have historically been below the detection limit. The discovery revises the understanding of the presence of microbes and the role of nutrient cycling in this little-studied but essential ecosystem.

Image credit: Alex Ingle / Schmidt Ocean Institute

The science team also used a HyperPro multi-wavelength optical sensor and a Pump Profiling System to collect high-resolution data about an ecosystem invisible to the human eye. A Submersible Incubation Device, or SID, is an automated mini-laboratory that collects and processes seawater samples *in situ* at specified depths while accurately measuring the amount of oxygen in the water. It allowed scientists to infer the amount of nutrient cycling occurring naturally under the low-oxygen conditions rather than attempting to simulate them back in the lab. The equipment is built with only glass and titanium, preventing oxygen contamination during experimentation.

The scientists will continue to analyze the data from the expedition at their onshore labs to determine the implications of being able to detect oxygen in the OMZ. Their findings may offer a new paradigm for studying this globally significant environment and the technology used and research outcomes will generate new insights into how it functions. Moving towards *in situ* and high-resolution monitoring and sampling systems redefines how OMZs are studied and reshapes hypotheses on how these microorganisms operate. Whenever unique environmental systems are explored with newly developed technologies, it opens the door to discovering unexpected processes and phenomena.

RESULTING HIGHLIGHTS INCLUDE:

- Successfully testing multiple technologies that can collect data to address significant knowledge gaps in understanding of OMZs, including the mTail sensor.
- Substantially improving our understanding of the biogeochemical and community dynamics associated with oxygen depletion and providing key parameters for predictive modeling of these regions.
- Measuring sporadic pockets of water with trace amounts of oxygen in an area of the Southeast Pacific where oxygen has historically been below the limit of detection. The discovery revises understanding of microbes and nutrient cycling in a little-studied but important ecosystem: OMZs.

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