Corals as Natural Archive of Environmental and Climate Changes

For the last three years, Dr. Intan Suci Nurhati had gone on expeditions to islands off Singapore, Indonesia as well as Kuwait in search of large corals. She and her collaborators meticulously planned their expeditions months in advance to decide which coral reef islands to go to, how to get there and return safely and, also importantly, what they needed to retrieve from the corals.

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On these expeditions, they collected small samples of coral with minimal impact to the beautiful creatures and shipped the samples carefully to the laboratory to facilitate a range of subsequent geochemical analyses.

Dr. Intan is a Postdoctoral Associate at the Singapore-MIT Alliance for Research and Technology (SMART)'s Centre for Environmental Sensing and Modelling (CENSAM) located at the National University of Singapore campus. She is also a member of Singapore's Climate Science Experts Network by the Ministry of Environment & Water Resources.

With her colleagues in other universities and institutions in the region and around the world, Dr. Intan and her collaborators have been working together and sharing their collections of coral samples from the Indian Ocean and Southeast Asia namely Singapore, Indonesia, Thailand,as well as the Chagos Archipelago and Kuwait.

Answers from corals

Why corals? "Our research group at SMART is led by Prof. Ed Boyle of MIT, one of world's most renowned marine chemists, and we study corals from Singapore and the Indian Ocean to understand the imprints of heavy metal lead that are caused by human activities in our seas," said Dr. Intan.

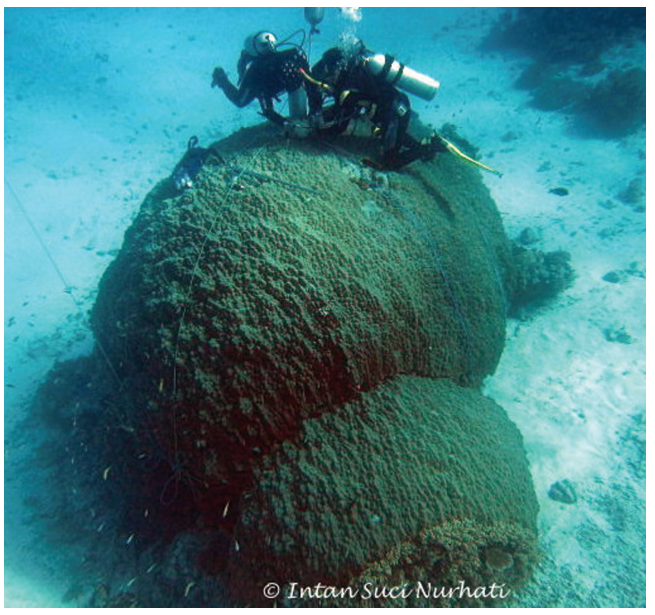
"The use of leaded gasoline had been phased out in the U.S. and Europe since 1970s due to its damaging effects to our brains. And corals have been crucial in providing us with records of lead concentration and source in our marine environments. However, leaded gasoline had only been phased out in our region in recent years. Therefore, we needed data sources that could capture changes in the environment over a long period of time, in this case over the past decades," she explained.

"We are the first research group to take on this research in this region. Additionally, our research group at SMART has also been conducting paleoclimate (or past climate) research by reconstructing changes in monsoon variability in Southeast Asia over the last century. Indeed, the best source of data for both researches is coral," said Dr. Intan.

She went further to explain that corals are nature's own archives. "Corals provide us with a wealth of environmental data extending from the distant past to present. For instance, the fast-growing Porites corals can grow for decades to centuries at a rate of about 1 to 2 cm per year. Just like trees, corals also have annual banding as they deposit layers of calcium carbonate through time. The geochemical composition of each layer reflects environmental conditions at the time of deposition. Hence, by studying coral skeletal geochemistry, we are able to reconstruct high resolution (such as monthly or yearly) and precisely date past environmental events that occurred in the last centuries."

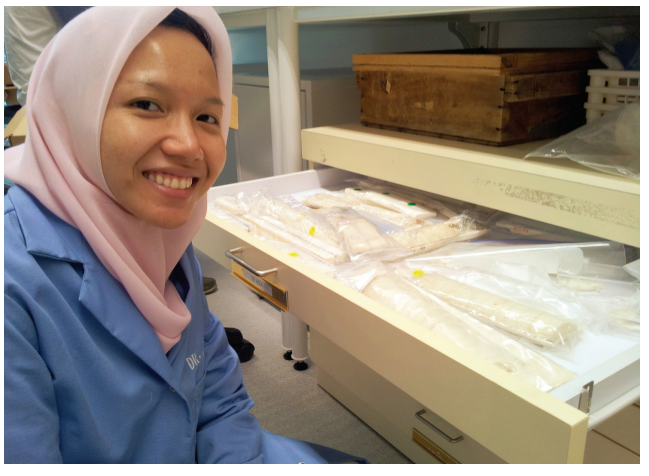
Analysis of corals

Dr. Intan had been studying the coral skeletal geochemistry to map the changes in the environment over a period of 8 years. Through diving expeditions and from her network of collaborators, she has been working through dozens of coral samples. She explained that about 2 years of their research time was spent on processing and analysing the data from these coral samples in the laboratory.



The labour-intensive process involved painstakingly and carefully cutting the small cross-sections of coral collected, putting them through X-rays before finally running sections of them through an atomic spectroscopy instrument, the Agilent 710-ES ICP-OES (inductively coupled plasma optical emission spectrometer).

The Agilent 710-ES ICP-OES instrument provided her with strontium and calcium readings. Calcium is the main building block of coral. Whereas strontium, which belongs to the same group of alkaline earth metal with calcium and is fairly abundant in seawater, gets incorporated into coral skeleton in proportion with temperature changes. As such, Dr. Intan used the reading of these two chemical elements to reconstruct temporal changes of ocean temperature for her climate change studies.



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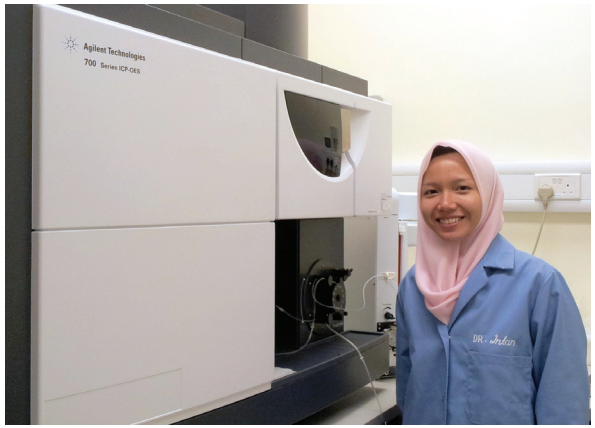

"In the lab, we look for measurements of coral oxygen isotopic ($\delta^{18}O$) composition and strontium-to-calcium ratio in coral skeletons in order to reconstruct past sea surface temperature and salinity/rainfall over the past centuries," she said.

She added that the Agilent 710-ES ICP-OES is a low-maintenance instrument which eased her lab operation at SMART because she could easily start the machine up to run her samples even after going off on weeks of expedition, work travel or when she has to commit her time on other works such as analysing data, giving presentations and writing her research. "Unlike many other analytical instruments, I do not need a lab technician nor student to maintain it while I'm away," she said. The instrument gave her a one-view, one-step measurement of major, minor, and trace elements and had been highly reliable and robust.

Mapping the past for the future

Her research work continues to be driven by two burning questions: What are the changes to the monsoon over the past century and what is the history of heavy metal lead in our oceans?

Her efforts to brave the elements to collect the data and painstakingly analyse these in the laboratory will help to provide detailed records of past climate variations. This could then serve as a benchmark for improving regional climate models in Southeast Asia. "In all, our climate and environmental researches have been benefited from studying corals as a natural archive. Therefore here we also collaborate with biologists in the region so that we can contribute to helping them understand how the changes in environment have been affected the corals using these coral-derived records."

Agilent ICP-OES

The Agilent 710-ES ICP-OES was launched in 2006 as part of a range of instruments for elemental analysis designed to meet the needs of scientists working in a variety of application areas ranging from environmental to pharmaceutical. This is an instrument designed for laboratories performing routine ICP-OES analyses. These instruments are ideal for educational institutes and for industries that need to comply with environmental protection laws and regulations such as the European Union's directives on the Restriction of the use of Hazardous Substances (RoHS) and on Waste Electrical and Electronic Equipment (WEEE). Core to the instrument is a proprietary CCD detector that delivers the world's best performing and fastest ICP-OES platform, ideal for high-throughput contract laboratories in environmental, petrochemical and geological applications.