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GEOTRACES research voyages: Studying rare substances in the oceans

By Chris Parsons
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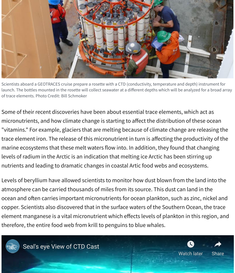
Trace elements are rare but can be incredibly important. Some, such as iron, are micronutrients - similar to vitamins, they are needed only in very small amounts but are essential. Others, like mercury or cadmium, can be toxic. Certain trace elements can be important indicators that help scientists better understand ocean dynamics. For example, levels of a form of neodymium can help scientists monitor ocean circulation. Many trace elements are also helping scientists understand the oceans' role in climate change, both in the past and the present, which can help predict climate in the future.



GEOTRACES researchers work on the Arctic ice with the US Coast Guard icebreaker Healy in the background. Photo Credit: Bill Schmoker

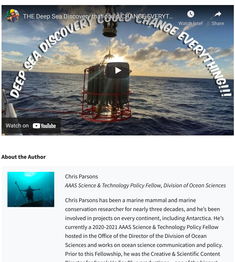
What the ocean can tell us about the health of the planet

The GEOTRACES program studies the occurrence of these rare but very important elements in the oceans. This globally-focused initiative, supported by the U.S. National Science Foundation's Chemical Oceanography Program, aims to map and understand the processes controlling the global distribution of dozens of trace elements and isotopes, or different forms of an element with slightly different atomic weights, from research conducted aboard oceanographic vessels. Scientists can get a better understanding of how trace elements affect biological productivity, climate change and historical environmental conditions from these data and are making an atlas of trace element distribution .

Scientists aboard a GEOTRACES cruise prepare a rosette with a CTD (conductivity, temperature and depth) instrument for launch. The bottles mounted in the rosette will collect seawater at a different depths which will be analyzed for a broad array of trace elements. Photo Credit: Bill Schmoker

Some of their recent discoveries have been about essential trace elements, which act as micronutrients, and how climate change is starting to affect the distribution of these ocean "vitamins." For example, glaciers that are melting because of climate change are releasing the trace element iron. The release of this micronutrient in turn is affecting the productivity of the marine ecosystems that these melt waters flow into. In addition, they found that changing levels of radium in the Arctic is an indication that melting ice Arctic has been stirring up nutrients and leading to dramatic changes in coastal Artic food webs and ecosystems.

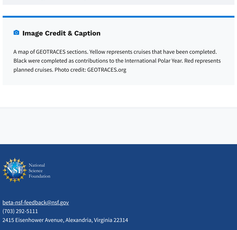
Levels of beryllium have allowed scientists to monitor how dust blown from the land into the atmosphere can be carried thousands of miles from its source. This dust can land in the ocean and often carries important micronutrients for ocean plankton, such as zinc, nickel and copper. Scientists also discovered that in the surface waters of the Southern Ocean, the trace element manganese is a vital micronutrient which affects levels of plankton in this region, and therefore, the entire food web from krill to penguins to blue whales.



A true global partnership

An important factor in the development of GEOTRACES was the realization that the problems facing the world's oceans were too large for any one nation to handle. Thus, the investigators were aware from the beginning that international collaboration was essential. To date, 124 research voyages have been completed, with 19 countries involved in leading these expeditions: USA, U.K., France, Germany, the Netherlands, Japan, Australia, New Zealand, China, Taiwan, Canada, India, Spain, Sweden, Poland, South Africa, Brazil, South Korea and Israel.

GEOTRACES operates international summer schools and holds training workshops in locations such as India, South Africa, South Korea and China, and also employs a diverse team of early career researchers. These scientists get hands-on experience helping to plan and execute expeditions, and learn to conduct open ocean research, handle the latest marine science technology and address the unique challenges of conducting lab work at sea.



GEOTRACES is a multinational effort with researchers from 35 countries involved. In this picture, researchers from the Stellenbosch University in South Africa in their laboratory. From left to right: Makendra Roychoudhury, Natasha van Horsten, Thato Mtshali and Susanne Fietz. Photo Credit: Mirja-Fourie Basson

"It is one thing to work on science in relative isolation but conducting science among a diverse group is inspirational and motivating," said Laura Whitmore, a postdoctoral researcher with the University of Alaska Fairbanks. "GEOTRACES promotes collaboration and discussion through workshops, but the time spent at sea with other scientists can't be beat as a way to learn about and be inspired by research."

Wen-Hsuan Liao with the Institut Universitaire Européen de la Mer in Plouzané, France, was an early career researcher participating in GEOTRACES. "Experiencing different cultures and learning from scientists from different countries was a big plus to me. I made a lot of friends through this international program, both senior scientists and the ones in my generation," said Liao.

GEOTRACES is providing essential data on ocean chemistry, climate change, and the nature and functioning of the oceans. The program is also a role model for international partnership and coordination in order to achieve major scientific endeavors. This is one of the reasons why the United Nations has endorsed it as one of the official Ocean Decade Actions of the U.N. Decade of Ocean Science for Sustainable Development .

The GEOTRACES program may be searching for rare elements, but the elements of collaboration, collegiality and camaraderie are some of the commonest features of their expeditions.

NSF funds other ocean trace element research, too. Dr Brian Haley (who is also part of the GEOTRACES team) is conducting a study on trace elements in ocean sediments - as explained by Larkin Bohn in this video.

About the Author

Chris Parsons
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Chris Parsons has been a marine mammal and marine conservation researcher for nearly three decades, and he's been involved in projects on every continent, including Antarctica. He's currently a 2020-2021 AAAS Science & Technology Policy Fellow hosted in the Office of the Director of the Division of Ocean Sciences and works on ocean science communication and policy. Prior to this Fellowship, he was the Creative & Scientific Content Director for Speak Up For Blue productions - one of the biggest independent nature podcasting companies globally, for whom he hosted and produced several marine science and environmental podcasts. Before that, he was an Associate Professor in the Dept. of Environmental Science & Policy at George Mason University as well as the Director of their undergraduate program in environmental science. In addition to writing a textbook on marine mammal biology & conservation, Chris has published over 180 scientific articles and book chapters on whales and dolphins and conservation. However, the podcast (Dungeons & Seadragons) and four books he has worked on that combine marine science and the roleplaying game Dungeons and Dragons are probably his favorite projects. His claim to fame is that science fiction writer Douglas Adams gave him his old typewriter on which he wrote The Hitchhikers Guide to the Galaxy.

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A map of GEOTRACES sections. Yellow represents cruises that have been completed. Black were completed as contributions to the International Polar Year. Red represents planned cruises. Photo credit: GEOTRACES.org

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