Moving iron in Antarctica: New study on carbon dioxide absorption in Antarctic seas

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Georgia Tech Professor Ellery Ingall studied diatoms and their role in cycling iron in Antarctica. Colonies of diatoms living in the ice typically produce brown layers. Ingall collected samples while onboard the Swedish ship Oden (pictured). Credit: Ellery Ingall

The seas around Antarctica can, at times, resemble a garden. Large-scale experiments where scientists spray iron into the waters, literally fertilizing phytoplankton, have created huge man-made algal blooms. Such geoengineering experiments produce diatoms, which pull carbon dioxide out of the air. Experts argue that this practice can help offset Earth's rising carbon dioxide levels. However, the experiments are controversial and, according to a new study at the Georgia Institute of Technology, perhaps not as effective as expected.

Georgia Tech research published online Monday in *Nature Communications* indicates that diatoms stuff more iron into their silica shells than they actually need. As a result, there's not enough iron to go around, and the added iron may stimulate less productivity than expected. The study also says that the removal of iron through incorporation into diatom silica may be a profound factor controlling the Southern Ocean's bioavailable pool of iron, adversely affecting the ecosystem.

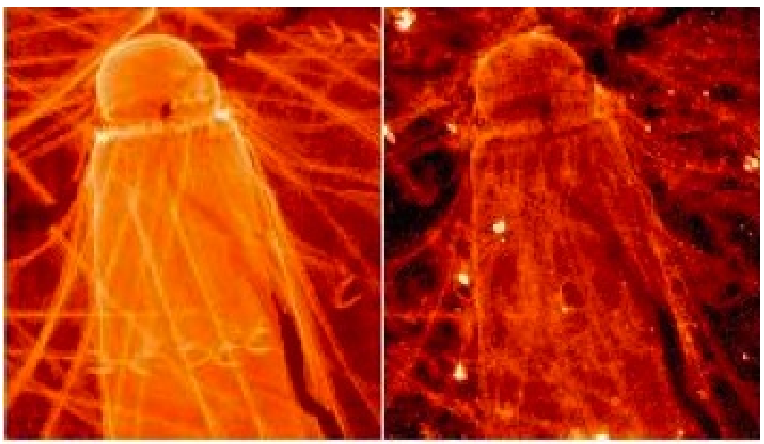
"Just like someone walking through a buffet line who takes the last two pieces of cake, even though they know they'll only eat one, they're hogging the food," said Ellery Ingall, a professor in Georgia Tech's College of Sciences. "Everyone else in line gets nothing; the person's decision affects these other people."

Ingall says, similarly, these "hogging" diatoms negatively affect the number of carbon-trapping plankton produced. They also outcompete other organisms for the iron.

"It appears the diatoms aren't using all of the iron for photosynthesis," he said. "They're incorporating iron in their shells for another purpose, keeping it from others and affecting the plankton ecosystem."

Researchers have known for years that diatoms can remove iron from oceans and carbon from the atmosphere, but little is known about how iron is cycled and removed from the Antarctic region.

Ingall and a former Georgia Tech graduate student, Julia Diaz, spent nearly six weeks in Antarctica's Ross Sea from 2008 to 2009, trying to learn more. They collected samples in the frigid waters and used them to create what is believed to be the first spectroscopic, compositional characterization of iron in marine biogenic silica. Ingall conducted an X-ray analysis of the phytoplankton at the U.S. Department of Energy's Argonne National Laboratory.



Left: This is a map of silicon distribution in a diatom. Right: This is a map of the distribution of iron in the same diatom. Lighter colors indicate higher concentrations. Note how the distribution of iron mirrors the distribution of silicon. Credit: Ellery Ingall

A major source of bioavailable iron in Antarctica is from melting snow and dust deposition. Ingall found that iron addition via these sources barely keeps pace with subtraction by diatoms.

"Uptake of iron by diatoms is significant compared to what Mother Nature is able to naturally add to the ocean," he said. "This uptake could shift microbial communities toward organisms with relatively lower iron requirements."

According to Ingall, removal of iron by diatom-dominated phytoplankton communities may dampen the intended outcome of enhanced carbon uptake through iron fertilization by reducing the productivity of other phytoplankton, which take up carbon dioxide more efficiently.

Provided by Georgia Institute of Technology

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