Researchers Use Synchrotron to Shed Light on Cadmium's Role in Carbon Cycle

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An international team that includes two University of Saskatchewan Canada Research Chairs has discovered that the element cadmium, well known for its toxicity to humans and other animals, may play an essential role in regulating atmospheric carbon.
The findings will be published in the May 5, 2005 issue of the prestigious science journal *Nature*.

The team includes U of S geological sciences professors Graham George and Ingrid Pickering and colleagues from Woods Hole Oceanographic Institute in Massachusetts, Sandia Laboratories in California, ExxonMobil Research and Engineering, and Princeton University in New Jersey.

Working at the Stanford Synchrotron Radiation Laboratory in California, George and Pickering used synchrotron X-rays to partly determine the shape of an enzyme that regulates levels of carbon dioxide in single-celled plants called diatoms. Colleagues on the team isolated the genes responsible for the cadmium enzyme, which also appear to be unique.

George and Pickering confirmed that the plant enzyme, cadmium carbonic anhydrase, does indeed use cadmium – the first known biological use of the element.

“Our research establishes a role for cadmium for the first time. No one has done this before,” George says.

The team found that the cadmium enzyme performs much the same role as zinc-based enzymes in land plants. The U of S researchers compared the two types of enzymes using data generated at the Stanford synchrotron.

“It turns out that cadmium may play a vital role in the global carbon cycle,” George says. “The enzyme is used by diatoms in the first step of photosynthesis, which is responsible for uptake of carbon dioxide from the atmosphere.”

Like all plants, diatoms use photosynthesis to take in carbon dioxide and release oxygen. Since they are present in all the world’s oceans, which cover about 70 per cent of the Earth’s surface, diatoms have a huge collective impact.

The researchers speculate that the diatoms’ capacity to use cadmium developed because ocean waters contain only trace amounts of certain essential metals. In fact, the diatoms prefer to produce a zinc-based enzyme rather than the cadmium version. But the ability to make a cadmium enzyme allows the microscopic plants to better survive in their environment because surface seawater contains almost no zinc.

Until now, cadmium was thought to be something solely to be avoided. While our bodies can get rid of the metal, excessive amounts can damage the kidneys, bones, nervous and cardiovascular systems.

Cadmium has many industrial uses such as nickel-cadmium rechargeable batteries, paint pigments, plating, alloys, and plastics. It is a naturally occurring element and can accumulate in crops, prompting efforts, for example, to develop low-cadmium varieties of durum wheat for Saskatchewan soils.

“What’s interesting here is the changing face of cadmium from a bad guy

to a good guy," George says.

Source: University of Saskatchewan