

## Earth Sciences

Stefi Weisburd reports from San Francisco at the meeting of the American Geophysical Union

### Upping the oceanic uptake of CO<sub>2</sub>

While we humans, by burning fossil fuels, are adding carbon dioxide (CO<sub>2</sub>) to the atmosphere at an increasing rate, the shells of some dead ocean-dwelling, snail-like creatures called pteropods assimilate it. Pteropod shells contain a calcium carbonate mineral called aragonite that dissolves to form bicarbonate in the presence of CO<sub>2</sub>. Previously, scientists thought that another calcium carbonate mineral called calcite was the major oceanic sink of CO<sub>2</sub>. Aragonite was relegated to a minor role because it was not found in great quantities in sediment traps.

The reason for its relative absence is that many pteropods dissolve long before they reach the ocean bottom, says Richard A. Feely of the National Oceanic and Atmospheric Administration. In 1982, Feely and a team of scientists from the University of South Florida in St. Petersburg measured the flux of aragonite in the northern Pacific at depths greater than 100 meters where biologically generated CO<sub>2</sub> is high. They found that the aragonite flux is at least comparable to the calcite flux, and in some cases is up to five times greater. The researchers also report that the aragonite reacts very quickly with CO<sub>2</sub>; 5 to 20 percent of the smaller pteropods sinking toward the sea bottom never make it farther than 1,000 meters before they dissolve. The shells of larger pteropod species, while partially dissolved, sink to the bottom because they fall faster. The dissolution of pteropod shells and the subsequent production of bicarbonate also offer a needed explanation for the high alkalinity levels found in the mid depths of the northern Pacific.

While the recent findings suggest that aragonite may provide an important sink for atmospheric CO<sub>2</sub>, its impact on global CO<sub>2</sub> levels has yet to be assessed. However, the researchers have estimated the effect of rising CO<sub>2</sub> on the oceanic carbonate concentration. When the CO<sub>2</sub> concentration reaches its predicted value of 650 parts per million next century, aragonite in the surface waters of the northern Pacific, which are now relatively devoid of CO<sub>2</sub>, will just begin to dissolve, the researchers believe.

### From Africa to Miami with mud

For the past few summers it has rained red African mud in Miami. The showers wash down the iron-oxide-rich soil particles that have been carried on the winds across the Atlantic. "It's pretty dramatic when you drive to work some mornings and all the cars are covered with African mud [spots]. It looks like the measles," says Joseph M. Prospero, an atmospheric chemist at the University of Miami in Florida.

Since 1965, Prospero and co-workers have monitored the concentrations of soil dust, or airborne mineral particles, transported across the ocean to a measurement station in Barbados, West Indies (southeast of Miami). The researchers now report that in 1983 the station measured the highest levels of soil dust ever recorded since the study began. Prospero links this dramatic increase to the severe drought in North Africa. The only other time the researchers found unusually high concentrations was during another African drought in the early 1970s.

The 1983 soil dust levels were especially great during winter, when concentrations were 100 times greater than normal winter values, perhaps because of the 1982-83 El Niño episode that stirred up gusty winds, Prospero says. The end result in Miami in a one-year period was layers of soil dust deposited at rates comparable to the accumulations of deep-sea sediments.

Prospero stresses the usefulness of soil dust as a natural tracer of atmospheric circulation patterns and meteorological conditions over large areas of the globe. Soil dust data could help in the development of global transport models needed to study climate and weather, dispersion of human-made chemicals and nuclear winter. The gas tracers injected in the atmosphere in present research have only a limited range and must be used in very large quantities.

## Chemistry

### Pressing the jadeite look of gems

For centuries, artisans have worked with a tough, dull, glassy rock known as jadeite, carving and polishing this rare mineral into sparkling gems and miniature sculptures of green and lavender-tinged jade. Recently, jadeite was the focus of a different kind of transformation — one that harks back to the stone's origin deep in the hot, high-pressure interior of the earth.

Using a thimble-sized furnace and a huge diamond-making press, a team of researchers converted a mixture of powders (sodium, aluminum and silicon oxides) into samples of jadeite large enough to cut and polish into gems. The scientists, Robert C. DeVries and James F. Fleischer of the General Electric (GE) Research and Development Center in Schenectady, N.Y., claim to be the first to synthesize gem-quality jadeite.

In the jadeite-making process, the powdered starting materials are first melted at 2,700°F and then cooled to form a glassy solid. Crushing and "refiring" the solid in a tiny furnace inside a diamond-making press, which reaches a pressure of 440,000 pounds per square inch, transforms the glass into a cylinder of white jadeite, a quarter of an inch thick and half an inch high. Such a synthesized sample has the same special crystal structure — a fine web of interlocking needles — characteristic of natural jadeite. The synthetic jadeite can be colored by the addition to the starting materials of traces of chemicals that contain chromium (to give the sample a green color) or manganese (to give lavender). The GE team has even synthesized samples that show layers of different colors.

### Creating alloys by chemical reaction

A team of researchers has discovered that there's more than one way to blend two metals to form an alloy. Traditionally, the making of a homogeneous alloy, in which one metal's atoms are spread evenly throughout the other metal, involves melting the starting materials at a high temperature, then cooling the liquid to form a glassy or crystalline solid. In the case of selenium and tellurium, which play an important role in photocopying systems, the method is complicated by the need to use special quartz containers that must be evacuated to keep air away from the metals. The molten mixture also must stay hot until chains of selenium atoms break apart and redistribute themselves within the liquid. Now, Thomas W. Smith and his colleagues at the Xerox Webster Research Center in Webster, N.Y., report in the Nov. 14 *JOURNAL OF THE AMERICAN CHEMICAL SOCIETY* a chemical method for preparing selenium-tellurium alloys. Says Smith, "The chemical process is a very simple one carried out in standard glassware and at room temperature."

The new method involves chemically reducing a mixture of organic compounds that contain selenium and tellurium. For example, when hydrazine is added to a mixture of diethyl selenite and tetraalkoxytellurane, a fine, black precipitate forms. The reaction generates both selenium and tellurium atoms, which happen to fall together to form tiny crystals in which a mixture of both atoms occurs. "It really was a surprise that we didn't end up with [separate] particles of selenium and particles of tellurium," says Smith. "You get a crystalline alloy very directly."

Just as surprising, says Smith, is the observation that the composition of the alloy formed in this way mirrors the ratio of the ingredients in the organic starting materials. "It allows us to make them in whatever proportion we want in a very facile, simple process. The key from the Xerox point of view is the simplicity of the process."

Smith and his group have also managed to prepare chemical alloys of selenium with sulfur and arsenic and alloys that involve three metals. "We hope that other researchers will pick up on [this method]," says Smith, "and work to extend the chemistry so that one can make alloys of, say, iron and chromium or other combinations."