

Ocean carbon chemistry and pH

Why does increasing the dissolved CO₂ concentration in seawater affect shell building in marine organisms?

Dissolving CO₂ in seawater causes a suite of changes in the carbonate system in seawater, which may affect shell building in marine organisms. The formation of skeletons or shells in most marine organisms is an internal process where most organisms appear to convert bicarbonate to carbonate to form calcium carbonate. But because this conversion creates protons (hydrogen ions), the organisms must exert energy to expel the hydrogen ions into the external environment (seawater). One hypothesis as to why ocean acidification can cause slower calcification rates is that as seawater pH decreases, the organisms must exert more energy to rid themselves of the protons produced by calcification --- they are simply working against a steeper gradient. This explains why many calcifying organisms have lower calcification rates when they are physiologically taxed by other stresses (e.g. lack of food); that is, the added stress leaves the organisms with less energy for calcification. Ocean acidification can also indirectly affect shell formation through physiological impacts, such as changes in an organism's respiration rate, which can impact energy budgets and thus alter the animal's ability to produce shell material. While some organisms may grow their shells at normal rates under ocean acidification, the exposed parts of the shell may dissolve more quickly, so that the organism may need to spend more energy in shell maintenance, and less in reproduction or other life activities.

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Will CO₂ really decrease ocean pH all that much?

Scientists estimate that surface ocean pH has fallen by about 0.1 pH unit from preindustrial times to today. Because pH is a measure of hydrogen ion concentration and the pH scale is logarithmic — for every drop of 1 pH unit, hydrogen ion levels increase by a factor of 10 — a 0.1-unit pH drop is equivalent to about a 26% increase in the ocean hydrogen ion concentration. If we continue on the expected trajectory for fossil-fuel use and rising atmospheric CO₂, pH is likely to drop by 0.3-0.4 units by the end of the 21st century and increase ocean hydrogen ion concentration (or acidity) by 100-150% above what it was in preindustrial times. — *Scott Doney, Senior Scientist, Woods Hole Oceanographic Institution, USA*

Discussion Prompts:

1. How have humans contributed to ocean acidification?
2. How is ocean acidification affecting organisms in the ocean?
3. Why is the rate of ocean acidification alarming to scientists?

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