Chemistry 201

Ocean Acid-Base Chemistry

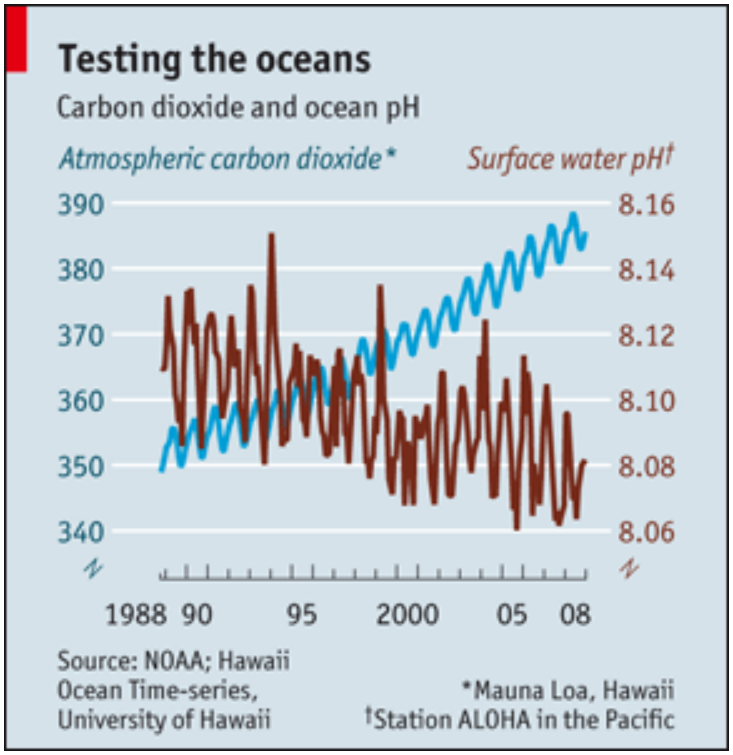
NC State University

Ocean acidification

CO_2 that is emitted into the atmosphere is taken up by the oceans. There is an equilibrium between the CO_2 in the atmosphere and the water. Once the CO_2 is dissolved it can dissociate. Thus, increasing CO_2 levels mean increased acidity in the ocean.

$$CO_2 + H_2O \rightarrow HCO_3^- + H_3O^+$$

$$HCO_3^- + H_2O \rightarrow CO_3^{2-} + H_3O^+$$



Carbonic acid: major determinant of ocean chemistry

Carbonic acid has two acidity constants. When CO_2 is taken up by water it reacts to form hydrogen carbonate. HCO_3^- is the major form of this acid.

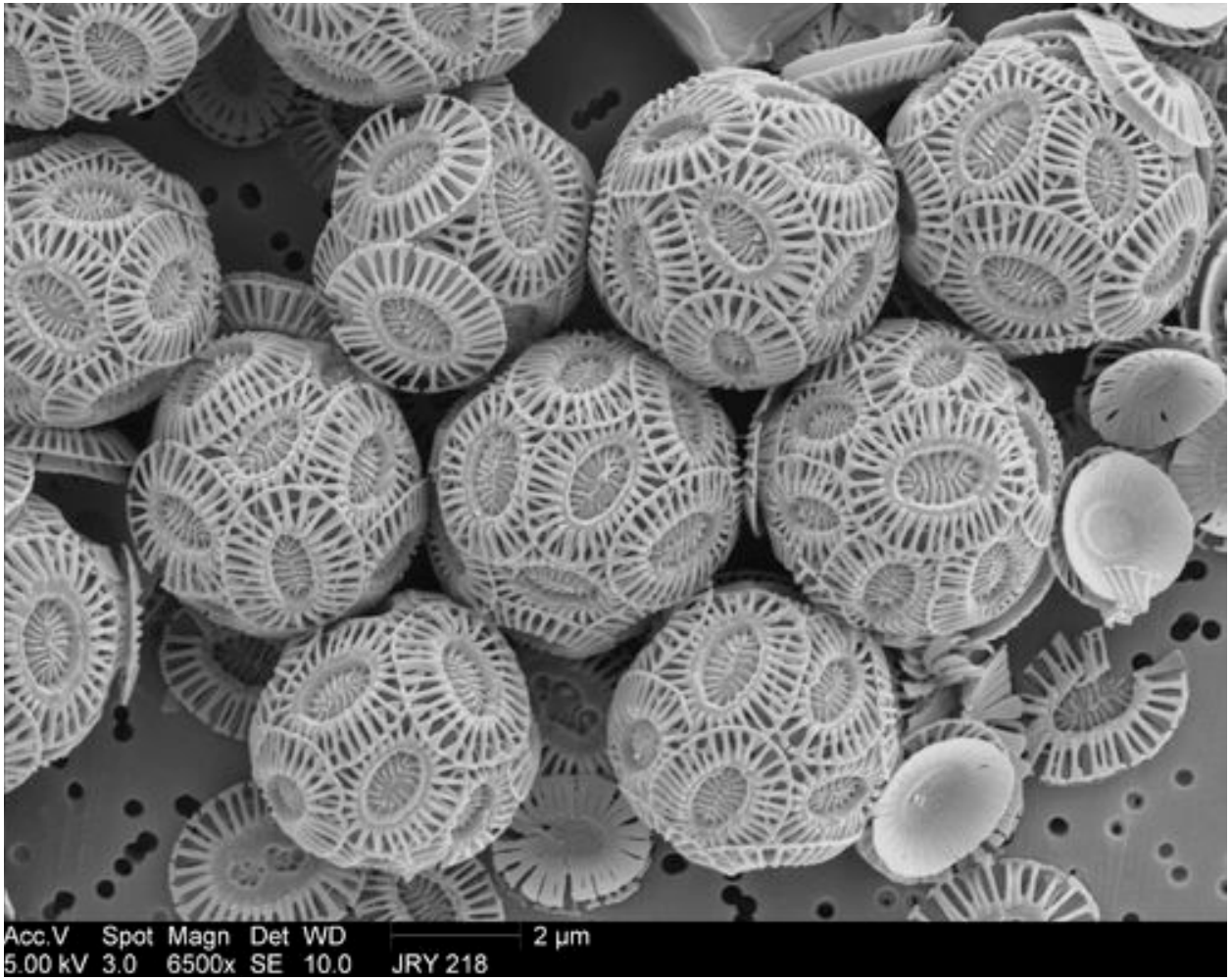
$$CO_2 + H_2O \rightarrow HCO_3^- + H_3O^+ \qquad K_{a1} = 4.5 \times 10^{-7}$$

$$HCO_3^- + H_2O \rightarrow CO_3^{2-} + H_3O^+ \qquad K_{a2} = 4.8 \times 10^{-11}$$

The balance of carbonate and hydrogen carbonate is very important for life in the ocean.

Coral reefs are highly colored collections of $CaCO_3$

Diatoms are microorganisms that fix CO_2 and produce O_2



Ratio of CO_3^{2-} and HCO_3^-

We can use the H-H equation to determine the ratio of CO_3^{2-} and HCO_3^-

$$HCO_3^- + H_2O \rightarrow CO_3^{2-} + H_3O^+ \qquad pK_{a2} = 10.3$$

The pH of the ocean is 8.1. However, 100 years ago it used to be 8.2. Using the H-H equation we can examine the ratio of these important ions today.

$$pH = pK_a + \log_{10}\left(\frac{[A^-]}{[HA]}\right) \qquad \frac{[A^-]}{[HA]} = 10^{pH-pK_a}$$

$$\frac{[CO_3^{2-}]}{[HCO_3^-]} = 10^{8.1-10.3} = 10^{-2.2} = 0.0063$$

Carbonate species in the ocean