# Aragonite Saturation State of Seawater

The precipitation and dissolution of aragonite in seawater can be described by the chemical reaction:

$$Ca^{2+} + CO_3^{2-} \leftrightarrow CaCO_3 \qquad (1)$$

where $Ca^{2+}$ is the dissolved concentration of calcium ions in seawater, $CO_3^{2-}$ is the dissolved concentration of carbonate ions in seawater, and $CaCO_3$ is aragonite. Note that the arrow ($\leftrightarrow$) denotes that the reaction can go both forward, left to right, or backward, right to left. The equation as read left to right is for the aragonite precipitation reaction and read right to left is for the aragonite dissolution reaction.

The saturation state of seawater with respect to aragonite can be defined as the product of the concentrations of dissolved calcium and carbonate ions in seawater divided by their product at equilibrium:

$$( [Ca^{2+}] \times [CO_3^{2-}] ) / [CaCO_3] = \Omega \qquad (2)$$

where dissolved calcium $[Ca^{2+}]$ is the seawater concentration of dissolved calcium ions, $[CO_3^{2-}]$ is the seawater concentration of carbonate ions, $[CaCO_3]$ is the solubility of aragonite in seawater, and $\Omega$ is the calculated saturation state.

When $\Omega = 1$, the seawater is exactly in equilibrium or saturation with respect to aragonite. In other words, the aragonite does not dissolve or precipitate. In relation to equation (1), equilibrium means that the forward precipitation reaction, left to right, and the backward dissolution reaction, right to left, are equal in their rate so there is no net precipitation or dissolution. When $\Omega > 1$, the seawater is said to be supersaturated with respect to aragonite. In this case, aragonite will precipitate or follow the left to right chemical reaction of equation (1). When $\Omega < 1$, the seawater is said to be undersaturated with respect to aragonite, which results in the aragonite mineral dissolving or following the right to left chemical reaction of equation (1).

When carbon dioxide is added to surface seawater from the atmosphere, the acidity of the surface seawater increases. If the surface acidity increases, then there is relatively less carbonate ion ($CO_3^{2-}$) in seawater, and thus the value of $\Omega$ decreases and so does the saturation state of seawater with respect to aragonite.