Solubility Controls

The leaching behavior of elements, and interpretation of leaching test results, is influenced by mineral solubility, oxidation-reduction state, and for carbonate minerals, the partial pressure of carbon dioxide. A proper interpretation of column leaching results and estimation of field performance requires consideration of solubility controls imposed on elements.

Carbonates, Alkalinity and Carbon Dioxide Partial Pressure

The aqueous carbonate system is described by a series of equilibrium equations including carbon dioxide gas as follows:

$$CO_{2\,(g)} + H_2O \leftrightarrow H_2CO_3$$
$$H_2CO_3 \leftrightarrow H^+ + HCO_3^-$$
$$HCO_3^- \leftrightarrow H^+ + CO_3^{2-}$$

and the dissolution of carbonate minerals, such as calcite as:

$$CaCO_3 \leftrightarrow Ca^{2+} + CO_3^{2-}$$

These reactions collectively determine the amount of carbonate that dissolves and the subsequent alkalinity concentrations. Figure 8-6 illustrates the effects of carbon dioxide pressure on pH and alkalinity when dissolving calcium carbonate in pure water. At normal atmospheric conditions, solution pH is about 8.3 and calcite solubility produces around 60 mg/L alkalinity. At the column test condition of 10% CO_2, or pCO_2 of 0.1, calcite solubility is increased to produce alkalinity approaching 350 mg/L. The use of 10% CO_2 for the test protocol had a significant effect on carbonate weathering and alkalinity concentrations.

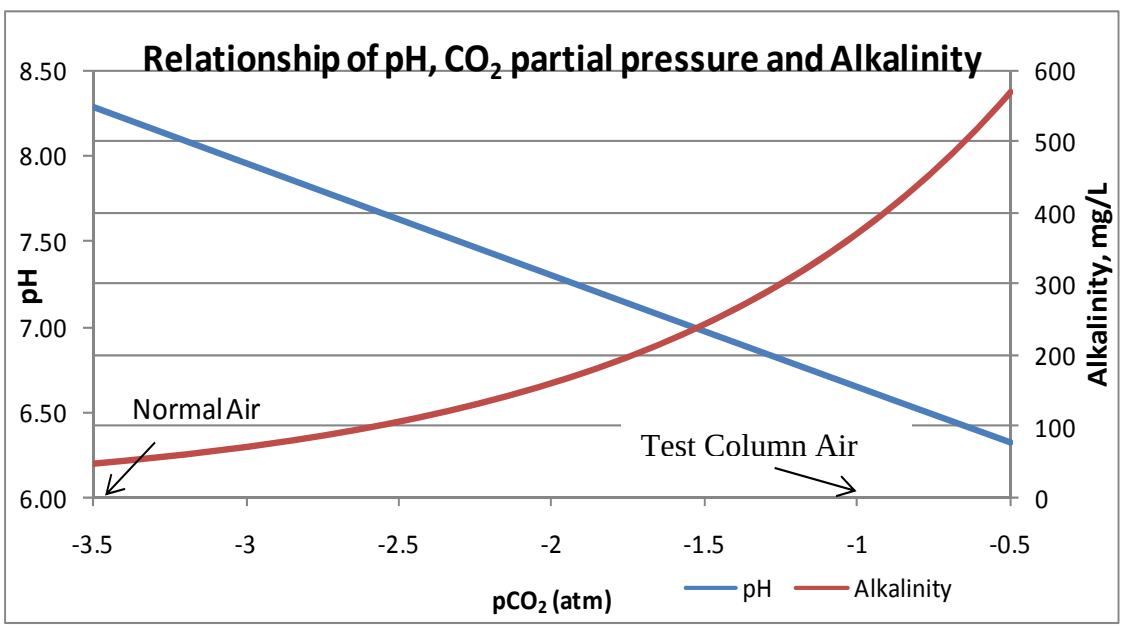

Figure 8-6. Effect of pCO2 on Alkalinity, pH and Calcium Carbonate Dissolution.