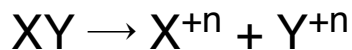


Solubility of minerals I: solubility products (K_{sp} values)

The solubility of a mineral that dissolves congruently (i.e., to leave no solid) can be characterized by an equilibrium constant that is the product of the activities of the solutes put into solution. This equilibrium constant (K) is called the mineral's solubility product (K_{sp}) because it is the products of activities of solutes.

For a mineral XY that dissolves via the reaction



the equilibrium constant expressing its solubility is

$$K_{spXY} = \frac{a_X \cdot a_Y}{\cancel{a_{XY(s)}}} = a_X \cdot a_Y$$

We can treat the activity of a solid as 1.

For example(s),

$$K_{sp\text{Calcite}} = a_{\text{Ca}^{2+}} \cdot a_{\text{CO}_3^{2-}}$$

$$K_{sp\text{Dolomite}} = a_{\text{Ca}^{2+}} \cdot a_{\text{Mg}^{2+}} \cdot a_{\text{CO}_3^{2-}}^2$$

$$K_{sp\text{Fluorite}} = a_{\text{Ca}^{2+}} \cdot a_{\text{F}^-}^2$$

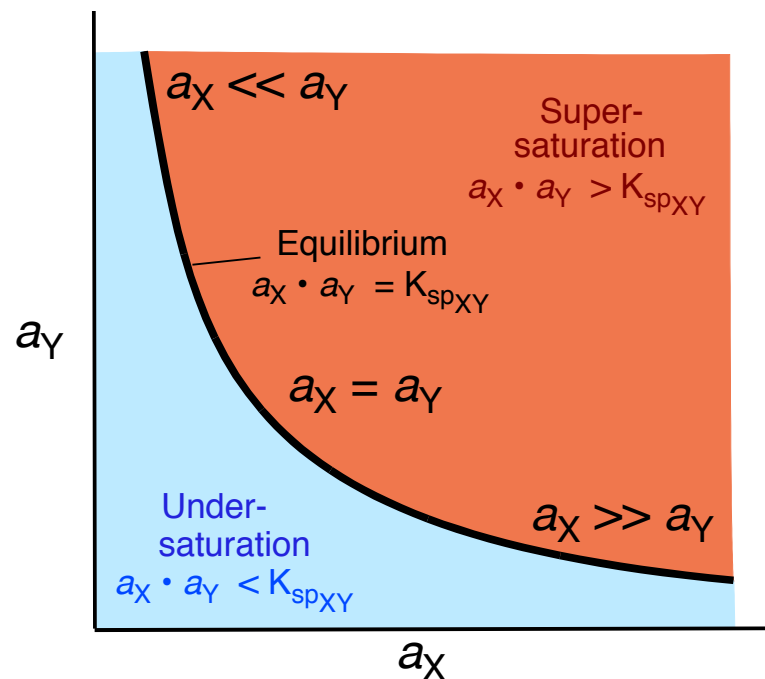
$$K_{sp\text{Quartz}} = a_{\text{H}_4\text{SiO}_4^0} = a_{\text{Si}(\text{OH})_4^0}$$

(so long as $a_{\text{H}_2\text{O}} = 1$)

Values of (K_{sp}) are commonly tabulated in textbooks of aqueous geochemistry or other reference works.

Equilibrium between mineral and solution exists when the product on the right side in these equations

equals the constant on the left. However, the relative proportions of the activities on the right can vary from equal to extremely uneven:



For example, natural solutions in equilibrium with calcite commonly have far greater $a_{\text{Ca}^{2+}}$ than $a_{\text{CO}_3^{2-}}$. A specific example is seawater, where $a_{\text{Ca}^{2+}}$ is very roughly 10^{-3} and $a_{\text{CO}_3^{2-}}$ is very roughly 10^{-5} , so that their product is about 10^{-8} and thus near the K_{sp} of aragonite – even though $a_{\text{Ca}^{2+}}$ is about 100 times $a_{\text{CO}_3^{2-}}$.