

The formation of Sr silicates at low temperature and the solubility product of tobermorite-like $\text{Sr}_5\text{Si}_6\text{O}_{16}(\text{OH})_2\cdot 5\text{H}_2\text{O}$

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ABSTRACT

The aqueous phase interaction of divalent Sr with silicate-containing solutions was studied over a range of pH values, dissolved silica, and Sr concentrations, and extending to basic solution (0.2 M NaOH) at room temperature (22–23 °C). Formation of an amorphous Sr silicate phase of variable composition was observed, beginning at approximately pH 10. The precipitate became quasi-crystalline at higher base concentrations and with aging time. The phase that formed at high base concentration (beginning at pH 11.5–12.0) was identified by total chemical analysis, X-ray diffraction, and thermogravimetric analysis to have a chemical formula of $\text{Sr}_5\text{Si}_6\text{O}_{16}(\text{OH})_2\cdot 5\text{H}_2\text{O}$, with a tobermorite-like structure. The $\text{Sr}_5\text{Si}_6\text{O}_{16}(\text{OH})_2\cdot 5\text{H}_2\text{O}$ phase has not been previously reported. Scanning electron microscopy (SEM) analysis of alcohol-washed precipitates showed a fine granular structure similar to Ca silicate hydrates. De-ionized water washing of the precipitates resulted in dissolution and growth of surface phases with the classical “sheaf of wheat” nucleation structure previously identified only for Ca silicate hydrates. Solubility studies of the precipitates, which extended to 286 days of equilibration, yielded an estimate of the solubility product of quasi-crystalline, tobermorite-like Sr silicate of $\text{Log } K = -38.0 \pm 0.7$ for the overall reaction, $5\text{H}_2\text{O} + \text{Sr}_5\text{Si}_6\text{O}_{16}(\text{OH})_2\cdot 5\text{H}_2\text{O} = 5\text{Sr}^{2+} + 6\text{H}_3\text{SiO}_4 + 4\text{OH}^-$. The first estimate of the association constant for the species $\text{SrH}_2\text{SiO}_4(\text{aq})$ of $\text{Log } K = 2.86$ was also made.