American Mineralogist, Volume 98, pages 1824–1833, 2013

Growth of calcium carbonate in the presence of Se(VI) in silica hydrogel

Ángeles Fernández-González[1,*] and Lurdes Fernández-Díaz[2,3]

[1]Department of Geology, Universidad de Oviedo, 33005 Oviedo, Spain
[2]Department of Crystallography and Mineralogy, Universidad Complutense de Madrid, 28040 Madrid, Spain
[3]Instituto de Geociencias (CSIC, UCM), C/ José Antonio Novais 2, 28040 Madrid, Spain

Abstract

The element selenium has become a considerable environmental concern due its accumulation in aquifers on the one hand and the high radiotoxicity of its long-lived isotope ^{79}Se on the other hand. Se(VI) is the most mobile of the various Se cations. This study deals with the interaction of Se(VI) with rock-forming minerals (carbonates) to better understand how to mitigate the potential environmental hazards of Se.

The effect of Se(VI) on the cystallization of $CaCO_3$ at room temperature was studied using the silica hydrogel method. The $CaCO_3$ crystals obtained were characterized by X-ray powder diffraction, scanning electron microscopy and electron microprobe. The presence of Se(VI) in the growth medium has a clear effect on the polymorph selection of $CaCO_3$, promoting the formation of vaterite and inhibiting that of aragonite. Se(VI) also affects the characteristics of calcite crystals, which show progressively more elongated habits and smaller sizes with increasing Se(VI) concentration in the growth medium. The effect of Se(VI) on both the polymorphic crystallization of $CaCO_3$ and the characteristics of calcite crystals shows features strikingly similar to those of other tetrahedral anionic groups like S(VI) and Cr(VI). This similarity extends to the amount of Se incorporated into the structure of the different $CaCO_3$ polymorphs, with calcite having Se contents up to 1200 ppm, vaterite up to 500 ppm, and aragonite growing virtually Se-free. The role of Se(VI) on the crystallization of $CaCO_3$ is discussed taking into consideration the physicochemical conditions in the growth medium at nucleation, which were modeled using the PHREEQ code for low-temperature aqueous geochemistry. The possible effect of the incorporation of the Se(VI) on the relative stability and, by extension, on the solubility of $CaCO_3$ polymorphs is also discussed.

Keywords: $CaCO_3$ polymorphism, Se(VI), $CaCO_3$ crystallization