

INCORPORATION OF ME IONS (Co, Cr AND Zn) DURING CALCIUM-ALUMINIUM-SILICATE-HYDRATE AND TRIOCTAHEDRAL SMECTITE FORMATION

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The contamination of ground and surface water by heavy metal (Me) ions is a global issue, as most of these potentially carcinogenic and/or cytotoxic components pose a significant health hazard. Consequently, the demand for cost-efficient natural and synthetic materials with a high Me ion removal capacity for water treatment applications is highly increasing.

Therefore, we assessed the mineralogy, crystal chemistry and nano-structure of calcium-aluminum-silicate-hydrate (C-A-S-H) and trioctahedral smectite precipitated at low to extremely high concentrations (1.9 to 188.5 mmol) of aqueous cobalt (Co²⁺), chromium (Cr³⁺) and zinc (Zn²⁺). For this purpose, hydrous aluminosilicate phases were synthesized by a sol-gel process with and without Me ions at different initial molar ratios of Ca/(Si+Al) (0.6, 1.0 and 1.6) and Me/Si (0.0, 0.02, 0.2 and 2.0), but constant Al/Si ratio of 0.05, at ambient temperature. The chemical evolution of the experimental solutions during aluminosilicate synthesis was analyzed by ICP-OES, whereas the characteristics of the precipitates were studied by ATR-FTIR, XRD and high-resolution TEM methods. At Me/Si ratios of ≤ 0.2 , C-A-S-H with a 14 Å tobermorite-like structure emerged, while at a Me/Si ratio of 2.0, either trioctahedral Co- and Zn-smectite or amorphous Cr-gels formed. The Me ion removal potential varied in the range from 99.99 % to 22.47 %, depending mainly on the initial Me ion concentration, type of Me ion used, evolution of pH and nature of the experimental precipitates. The immobilization capacities for Co²⁺, Cr³⁺ and Zn²⁺ ions by C-A-S-H, Cr-gels and trioctahedral smectite were determined as 3-40 mg/g, 30-152 mg/g and 122-141 mg/g, respectively (BALDERMANN et al., 2019). The removal mechanism for Me ions from solution was based on a combination of isomorphous substitution in the octahedral layer, cation exchange in the interlayer sites, surface adsorption and surface precipitation. It is concluded that the hydrous aluminosilicate phases reveal a high detoxification potential for Me ions, particularly under alkaline conditions, which is important, e.g., for assessing the Me ion mobility in engineered systems, such as in underground concrete structures and in waste disposal facilities.

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