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Investigation of simultaneous removal of fluoride and copper by induced crystallization using phosphate rock as a seed crystal

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ABSTRACT

In this study, the simultaneous removal of F^- and Cu^{2+} based on an induced crystallization mechanism using phosphate rock as a seed crystal was investigated. F^- and Cu^{2+} could be effectively removed simultaneously until seed crystal phosphate rock (PR) was reused three times, but high Cu^{2+} levels lead to more residual F^- when the operations were performed more than three times. F^- was removed by induced crystallization of $Ca_{10}(PO_4)_6F_2$ on the surface of PR, and Cu^{2+} was removed by co-precipitation with $Ca_{10}(PO_4)_6F_2$ as $Ca_{10-x}(Cu)_x(PO_4)_6F_2$ on PR. The retarding effect of Cu^{2+} on the removal of F^- may be explained as being due primarily to the obstruction by Cu^{2+} to the deposition of lattice ion Ca^{2+} on the surface of PR, hence, this hindered the induced crystallization of $Ca_{10}(PO_4)_6F_2$. For an artificial multiple contaminants groundwater application, the concentration of F^- was decreased from 2.88 to 0.9 mg L^{-1} while the other heavy metals (Cu^{2+}, Zn^{2+} and Pb^{2+}) were all removed absolutely with additional P to reach a P:F ratio of 6:1 and a contact time of 1 h. These findings highlight the application of induced crystallization for the removal of multiple pollutants, including F^- and typical heavy metal ions, from groundwater.

Keywords: Fluoride; Heavy metals; Phosphate rock; Induced crystallization; Co-precipitation

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